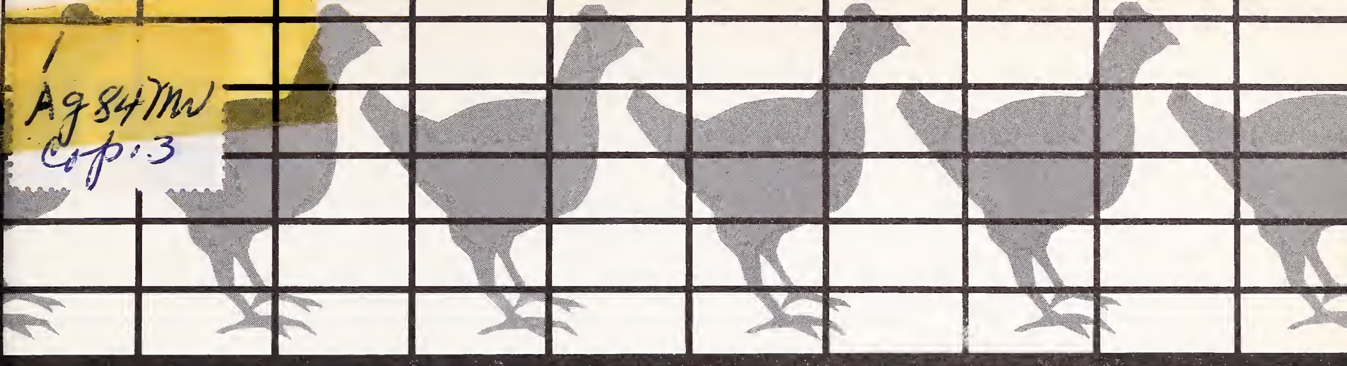
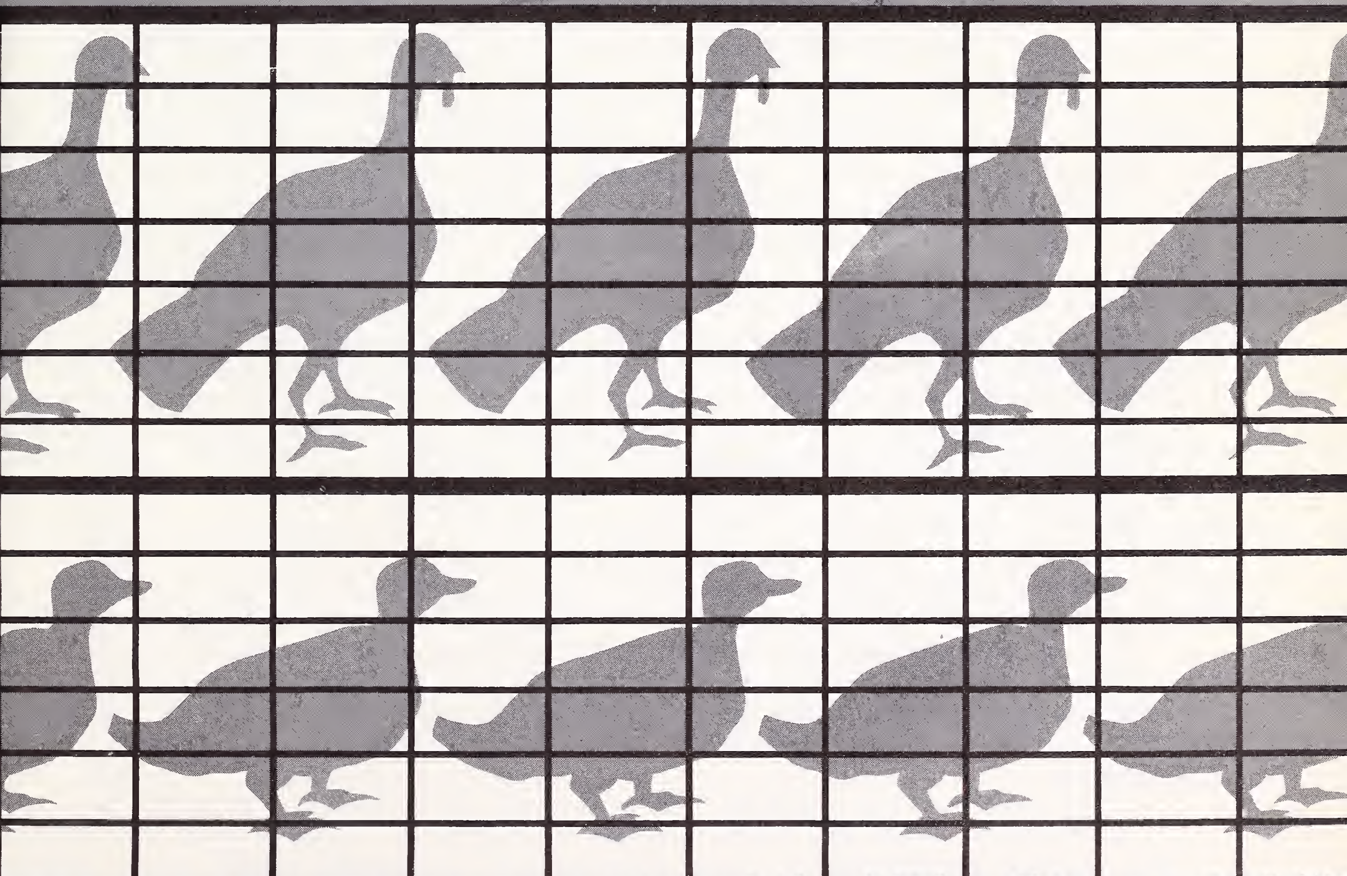


Utilization and Disposal of POULTRY BYPRODUCTS and WASTES



Marketing Research Report No. 143
UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service

Washington, D. C.
NOVEMBER 1956

PREFACE

Widespread interest in the improvement of returns from the utilization of byproducts from poultry slaughtering and evisceration prompted this study. This report is directed to members of the poultry industry and to persons or agencies who may be in a position to engage in further research in the field of byproduct utilization and waste disposal.

Credit is due John O. Gerald, O. C. Hester, Earl H. Rinear, and Norris T. Pritchard, all of AMS, for assisting in the field work for the study. Fred L. Faber, also of AMS, provided statistics regarding the distribution of slaughtering plants by size, location, volume of poultry slaughtered by season, and class of poultry. R. Rupert Kountz, professor of sanitary engineering, Pennsylvania State University, University Park, Pa., assisted by John M. Allen and Donald R. Vaughn, sanitary engineering students, assembled data and provided the analysis and estimates on waste water disposal.

CONTENTS

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 35 cents

SUMMARY AND RECOMMENDATIONS

It is possible to derive income from the utilization of byproducts of poultry slaughter plants, but these returns depend to a large extent upon efforts of slaughterers to locate and utilize desirable outlets effectively. In many areas, desirable or attractive outlets are not readily available. The byproducts--blood, feathers, and offal--comprise 20 to 30 percent of the weight of poultry killed; they totaled around 1.4 billion pounds in 1955.

Although most plants dispose of byproducts to renderers or farmers who make use of them as raw materials either in the manufacture of feeds, or as feed, or as fertilizer, less than half of the 343 plants surveyed in this study received any net income from disposal operations. Plants giving byproducts to renderers and farmers avoided practically all disposal costs, since the recipients generally furnished the containers and bore all cartage costs.

Net returns of those plants selling offal to renderers and farmers were mostly in the range of 25 to 50 cents per hundredweight. Volumes of offal regularly available and the distance of the plant from the renderer were the principal factors affecting prices paid. In general, the larger plants located in specialized poultry-producing areas received better prices. Prices paid by renderers for feathers were mostly \$2 to \$4 per ton at the slaughtering plant and about \$8 per ton delivered to the rendering plant. Few plants outside the specialized poultry-producing areas were able to sell feathers at any price unless sales were to feather commission houses. These houses paid 2½ to 6½ cents per pound for feathers from chickens and mixed poultry, and about \$1 per pound for feathers from ducks and geese. Feathers used in the millinery trade brought prices ranging up to \$2.50 per pound. Prices paid for blood by renderers were from 25 to 50 cents per gallon. Blood sold for use as fish bait brought prices ranging from 50 cents to \$1 per gallon.

Investment and operating costs for the 55 rendering plants providing information were relatively high compared to unit values of finished products. The most frequently reported prices received by renderers in 1955 for various finished products were: Bloodmeal, \$4 to \$8 per unit of ammonia; feathermeal, about \$65 per ton; poultry byproduct meal, \$80 to \$90 per ton; and grease, 6 to 6½ cents per pound.

Efficient rendering requires continuous large supplies of raw materials to offset low yields. The weight of rendered materials averages roughly 10 percent of the live weight of the poultry slaughtered. Large slaughterers and renderers tend to have a mutual affinity for one another because of renderers' need for large volumes to minimize assembly costs and slaughterers' need for reliable disposal outlets. Specialized facilities for rendering poultry byproducts are usually available in areas of concentrated production.

Practices at slaughtering plants in the handling and disposal of byproducts vary widely. Most plants collect offal and other byproducts within their plants manually. The several types of byproducts usually are kept separate in 55-gallon drums.

Some general steps which slaughterers may take to make byproducts more attractive to renderers are: Minimizing moisture content of byproducts before they leave the plant, keeping various byproducts separate, cleansing the viscera, filling drums properly, providing uniform daily volume, using bulk handling methods, and increasing mechanization if volume is great enough.

Disposing of sewage constitutes an additional problem. Poultry slaughterers can reduce sewage disposal problems by withholding manure, collecting blood, and using screens to collect bits of flesh and feather remnants before they leave the plant.

Disposal of sewage into municipal sewer systems frequently is the most economical means of disposal. However, where such facilities are not available, consideration should be given to disposal on the premises by spray irrigation, through tile fields, or by treatment in trickling filters before release into open streams.

Additional research is needed on the following subjects:

1. Costs and returns for utilizing inedible byproducts in various ways.

2. Improved efficiency in in-plant handling of inedible byproducts.

3. Equipment and methods for converting byproducts into a more storable and less bulky form, especially in small lots. This conversion would increase the value of products on a per-pound basis and permit accumulation of lots of optimum size for economical transportation. It would be well adapted to small plants and plants which do not now have satisfactory access to renderers or other desirable outlets.

4. Standardization of processing techniques and nutritive values for both separate and combined inedible byproducts. Standards of identity should be developed to facilitate public recognition and use of poultry byproducts.

5. Relative yields and chemical composition of rendered byproducts from various weights and classes of poultry.

6. Efficient methods of handling and feeding offal before drying.

7. Market development by exploring potential outlets and expanding present outlets.

8. Adaptation of customary sewage disposal or treatment devices to poultry waste disposal, and development of basic facts for use in designing facilities for sewage disposal.

UTILIZATION AND DISPOSAL OF POULTRY BYPRODUCTS AND WASTES

Humbert Scott Kahle and Leo R. Gray
agricultural economists,
Agricultural Marketing Service

OBJECTIVES AND METHODS OF THE STUDY

Unavoidable problems of byproduct and waste disposal have plagued the poultry slaughtering industry for many years. The problems have become more acute with development of large-scale commercial plants for poultry slaughter. Figure 1 illustrates the nature and quantity of disposable blood, feathers, and offal (viscera, heads, and feet) recovered from 100 broilers.

The problem of disposal of the inedible byproducts from 100 broilers is negligible, but the problem for large slaughtering plants handling thousands of broilers a day is of an entirely different magnitude. It assumes industrywide importance when one considers the more than 1.4 billion pounds of these products resulting from the slaughter of about 5.6 billion pounds of poultry nationally in 1955.

Poultry byproducts and wastes accumulate at every slaughtering plant and must usually be removed daily. Recoverable inedible byproducts (blood, feathers, and offal) comprise up to 30 percent of the live weight of all poultry killed. These materials deteriorate rapidly, attract vermin, create offensive odors, and are unsightly. Their high moisture content and considerable bulk make handling difficult. Where poultry are fed, manure accumulates at the rate of about 2 pounds of excreta per pound of feed intake. Large volumes of waste water result from dressing and evisceration operations. The present necessity for daily removal and the objectionable characteristics of the byproducts limit opportunities for profitable disposal by most slaughterers.

This study is a preliminary investigation of poultry byproduct utilization and related problems. It was designed to describe the nature and volume of byproducts and wastes from poultry slaughtering plants; to evaluate potentialities and limitations of existing uses of such byproducts; and to set forth needs for further research. This report is designed also to increase the interest and understanding of members of the poultry industry, poultry scientists, economists, and others in byproduct and waste disposal problems.

N-15931

Figure 1.--Volume of poultry byproducts from 100 broilers.

Interest in the disposal of inedible poultry byproducts was indicated by the Poultry Advisory Committee in 1947 soon after the Research and Marketing Act of 1946 was passed, and a continuation of this interest has been indicated in subsequent years (appendix, page 46).

To learn what disposal practices are followed nationally, visits were made to poultry slaughter plants in 52 areas throughout the United States. The sample areas included the 4 leading commercial broiler areas, 6 metropolitan areas, and 42 other areas selected by random grid sampling, based upon areas each having a minimum of 7 poultry processing plants. After adjustments for plants which had ceased operations and addition of plants about which no prior information was available, the sample consisted of 343 plants. Most of the data are based upon questionnaires completed during interviews at these plants. The sample of 55 rendering companies visited included only those renderers servicing the poultry slaughter plants contacted.

In addition to the data recorded in the questionnaires, the authors relied heavily upon personal observations of the plants.

UTILIZATION OF BYPRODUCTS FROM POULTRY DRESSING

In former years, "New York dressed" poultry was the type most commonly marketed. Only blood and feathers were removed and these therefore were the principal byproducts. The shift to the eviscerated product which is rapidly taking place adds the problem of offal disposal.1/ However, the development of poultry byproduct rendering facilities is made more feasible by the greater volume of raw materials which comes from evisceration.

Blood as Feed Meal Supplement

Blood may be allowed to run down a sewer as it drains from a bird or it may be collected at the bleeding tunnel (fig. 2). Slightly more than half (56 percent) of the plants drained blood into sewers. The remaining 44 percent collected blood for donation or sale (table 1). Collection of blood was most common among the large commercial plants in the Delaware-Maryland-Virginia peninsula, the Shenandoah Valley of Virginia, and north Georgia.

Blood is difficult to handle because of its high moisture content and perishability. The handling of blood sera, the liquid portion, depends on the sewage disposal facilities and the outlets for the whole blood or the coagulated fibrin. Where sewage disposal is not a problem, the moisture content can be reduced by draining off most of the blood sera. Blood fibrin and whole blood not washed down a drain are usually held in 55-gallon drums which must be closed or only partly filled to prevent spillage. The volume is small, since recoverable blood usually constitutes only 3 to 4 percent of

---

1/ The term "eviscerated" as used in this text refers to that poultry which is considered "drawn" as well as "ready-to-cook."

N-15919

Figure 2.--Collecting blood at the bleeding tunnel.

Table 1.--Blood disposal outlets and handling practices in poultry slaughtering plants, by type of area and size of plant, U. S., 1955.

Type of area and size of plant by volume of slaughter per week	Total	In-plant handling		Outlets used for blood saved				Out of plant handling	
		Drained away	Saved	Renderers	Farmers	Dump	Other	Outlet collect	Plant delivers
Thousand pounds	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Commercial 1/									
Under 30	-	-	-	-	-	-	-	-	-
30 - 99	100	50	50	100	-	-	-	100	-
100 - 299 ...	100	12	88	93	7	-	-	100	-
300 and over.	100	18	82	91	9	-	-	97	3
Total	100	18	82	92	8	-	-	98	2
Noncommercial									
Under 30	100	64	36	34	26	36	4	54	46
30 - 99	100	55	45	59	17	17	7	69	31
100 - 299 ...	100	52	48	41	22	28	9	48	52
300 and over.	100	48	52	72	21	7	-	71	29
Total	100	58	42	46	22	26	6	58	42
Total									
Under 30	100	64	36	34	26	36	4	54	46
30 - 99	100	55	45	60	17	17	7	70	30
100 - 299 ...	100	49	51	44	21	26	8	51	49
300 and over.	100	35	61	77	18	5	-	78	22
Total	100	56	44	49	21	25	6	60	40

1/ Commercial areas refer to those areas having a high concentration of large commercial poultry slaughtering plants. Areas so classified in this study are the heavy commercial broiler processing regions of north Georgia, northwest Arkansas, Shenandoah Valley, and the Delaware-Maryland-Virginia peninsula. All other areas have been classified as noncommercial.

the live weight of poultry, or about 1.5 ounces per 3-pound broiler. The high perishability of blood makes it difficult to hold relatively small amounts until a sufficient quantity can be accumulated to create a salable unit.

Renderers are principal outlets for blood

Collection of blood is common where renderers are available. Almost half of the plants collecting blood dispose of it through renderers, who use the blood in meat-scrap feeds. In rural areas, some farmers collecting feathers or manure from slaughtering plants for fertilizer also haul away blood, either separately or in a mixture of byproducts.

Most plants donate blood to renderers or anyone who will take it. Of the 169 plants saving blood, only 22 quoted prices they were receiving in 1955. The distribution of plants by prices received was:

Plants reporting sales (number)	Price per gallon (cents)
8	0 - 25
10	25 - 50
3	50 - 75
1	75 - 100
22	

Of the 22 plants, 17 sold blood to renderers. Limited quantities of blood were sold by 5 other plants (located in the West North Central Region) for use as fish bait. Four of these plants received more than 50 cents per gallon for blood. Renderers and a few farmers who do not pay for blood usually bear the costs of its removal from the plant. In some instances where no prices were quoted for blood itself, but where blood was collected along with other inedible byproducts, it is possible that prices paid for these other products partially reflected values of blood. However, 40 percent of the slaughterers bear out-of-plant blood handling costs themselves. Included in this group are plants disposing of blood through the dump or drain and through farmers.

Renderers can utilize blood by cooking it in combination with other animal byproducts or by cooking it alone until it is dried into bloodmeal. This is a high-protein feed supplement. It is also used as an organic fertilizer. Bloodmeal was being sold in 1955 to mixed feed manufacturers and fertilizer companies at prices ranging from about $4 to $8 per unit of ammonia. This is equivalent to $64 to $128 per ton of meal having an ammonia content of 16 percent.

Renderers' yields of bloodmeal average about 12½ percent of the weight of raw blood, and vary somewhat, depending largely upon methods of handling and moisture content. Blood collected from floors of slaughtering plants

consists primarily of the coagulated fibrin, the sera having drained off, and gives high yields. Blood collected in pans contains more moisture, and yields are lower.

Uses for Feathers

Feathers, as they come from the dressing room, are saturated with water, and are mixed with varying amounts of blood, manure, or other organic material. They have a moisture content of about 75 to 80 percent at this time. In a few hours, some of the water drains off unless the feathers are held in tight drums. If feathers are left in piles more than 24 hours, they may develop considerable heat and decompose rapidly.

Most slaughterers keep feathers separate from other inedible products. Some select feathers are dry-plucked by hand, but most are plucked by special machinery after the bird has been immersed in scalding water. The feathers are usually confined to a specific area of the plant until removed.

Methods of handling feathers are determined primarily by available outlets and by plant facilities. Plants disposing of feathers to renderers, farmers, and dumps rarely sort feathers, but feathers going to specialty outlets are sometimes sorted by type (table 2).

Most plants handle feathers in drums (fig.3). A mechanical conveyor discharging into a waiting truck is used for bulk handling in some large plants. Feathers may be moved to conveyors either by hand or by water, as in a "flow-away" system. Some other plants bale feathers with a machine that squeezes out about half the water.

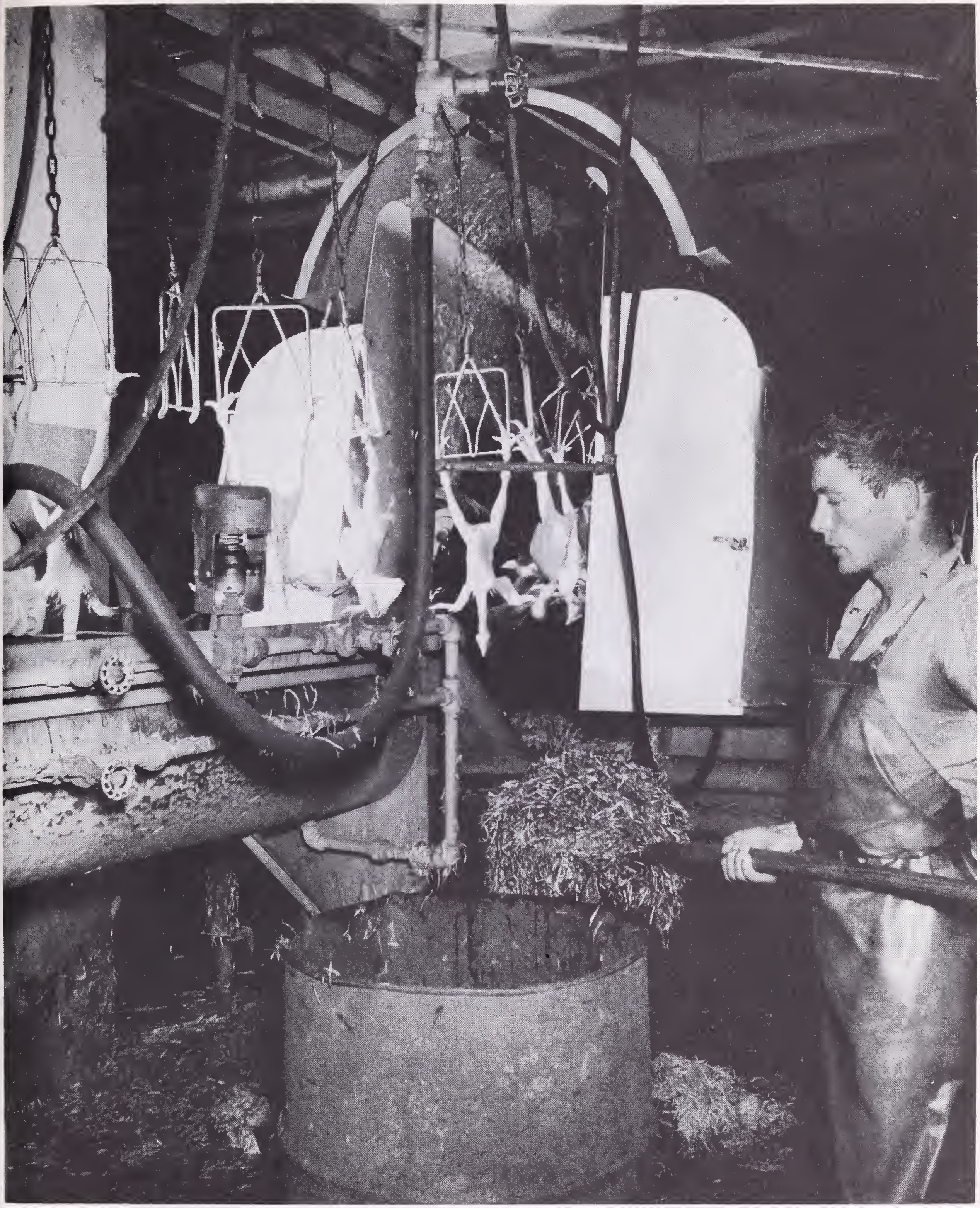
When drums are used or feathers are baled, an outside platform or special storage room is used to accumulate a day's supply (fig. 4). Although dry feathers make up only 3 to 5 percent of the live weight of poultry (1.5 to 2.5 ounces per average broiler), they are bulky and, because of their high water absorptive capacity, take on considerable weight when wet (see appendix, page 47). Feathers handled in bulk or in bales require less space and weigh less than feathers handled in drums. Therefore, the methods of handling affect transportation costs.

Feather renderers are seldom available in noncommercial areas

In 1955, about one-third of the slaughterers used renderers as an outlet for feathers. Renderers were the most common feather outlet for plants slaughtering over 100,000 pounds of poultry per week, especially in commercial poultry areas. Feather renderers or reduction companies require large volumes of raw materials for economical operation. Therefore, they seldom are available in noncommercial poultry areas.

Table 2.--Feathers: Disposal outlets and handling practices in poultry slaughtering plants, by type of area and size of plant, U. S., 1955.

Type of area and size of plant in poultry slaughtered per week	Total	In-plant handling		Outlets used for feathers				Out-of-plant handling		
		Sorted by type	Not sorted	Renderers	Farmers	Dump	Other	In bulk	In containers	Plant delivers
Thousand pounds	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Commercial										
Under 30	100	-	-	-	-	-	-	-	-	-
30 - 99	100	-	100	75	-	25	-	-	50	50
100 - 299 ...	100	-	100	94	6	-	-	19	69	12
300 and over.	100	-	100	98	2	-	-	35	57	8
Total	100	-	100	95	3	2	-	28	60	12
Noncommercial										
Under 30	100	1	99	19	27	48	6	6	20	74
30 - 99	100	3	97	35	31	28	6	11	27	62
100 - 299 ...	100	11	89	36	23	25	6	17	31	52
300 and over.	100	7	93	52	22	18	8	26	33	41
Total	100	4	96	29	27	36	8	12	25	63
Total										
Under 30	100	1	99	19	27	48	6	6	20	74
30 - 99	100	3	97	36	30	28	6	11	27	62
100 - 299 ...	100	10	90	39	22	24	15	17	34	49
300 and over.	100	5	95	65	16	13	6	29	40	31
Total	100	4	96	33	25	34	8	13	27	60



N-15926

Figure 3.--Collecting feathers from picking machine area.

N-15925

Figure 4.--Storing feathers on platform in drums.

About one-third of the renderers paid for feathers received in 1955. Reported prices ranged from $1 to $10 per ton, but mostly $2 to $4 per ton at slaughtering plants and about $8 per ton at rendering plants. Only the larger processors located in the more concentrated commercial poultry areas were receiving payments from renderers for feathers. However, renderers who do not pay for feathers usually bear costs of their removal from slaughtering plants.

Since large volumes of raw feathers seem to be essential for feather reduction companies, it is not surprising that most plants receiving payment for feathers slaughter more than 100,000 pounds of poultry per week (table 3). Their proximity to renderers and their ability to supply large volumes of feathers also affect prices they receive.

Only one processor reported receiving payment from a farmer for feathers, manure, and blood for use as fertilizer. Although some farmers collect feathers at plants for use as fertilizer, most slaughterers bear the costs

of delivering feathers to farmers. Where feathers are hauled to a town dump or incinerator, the slaughterer receives no income and he usually incurs cash costs of disposal.

Table 3.--Poultry slaughterers reporting feather sales to renderers and other outlets by size of plant, U. S., 1955.

Size of plant by volume of slaughter per week	Plants reporting feather sales to		
	Renderer	Other outlets	All outlets
Thousand pounds	Percent	Percent	Percent
Under 30	1	11	12
30 - 99	8	10	18
100 - 299	26	18	44
300 and over	24	2	26
All plants	59	41	100

Although the number of plants disposing of feathers to outlets other than renderers is comparatively small, three-fourths of these outlets, mostly feather commission houses, purchase feathers, and some pay high prices.

Some feathers are purchased in wet form for processing into filling materials. If properly cleaned, feathers can be used in their natural state as filler material in pillows, quilts, mattresses, and upholstery. Smaller quantities of selected types are used in the millinery trade and for feather dusters, fishing tackle, shuttlecocks, artificial flowers, pipe-cleaners, artists' brushes, writing quills, and toys (3: 10).2/ In such uses, chicken and mixed poultry feathers, after washing and drying, can be sold for $2\frac{1}{2}$ to $6\frac{1}{2}$ cents per pound. The most frequently reported price for firms visited in 1955 was $4\frac{1}{2}$ cents. Feathers obtained from ducks and other waterfowl brought much higher prices, ranging from 95 cents to $2.50 per pound and averaging about $1 per pound. The highest prices were paid for select fancy feathers for use in the millinery trade or for other special purposes.

Fancy feathers include rooster neck hackles, rooster tails, and feathers from turkey hips, necks, backs, wings, and tails. These must be plucked dry before the bird enters the scalder and must be kept separate from other body feathers. The utilization of feathers in this manner is most often encountered in small dressing plants where relatively slow operating speeds give employees time for dry plucking.

2/ Underlined numbers in parenthesis refer to Bibliography, page 50.

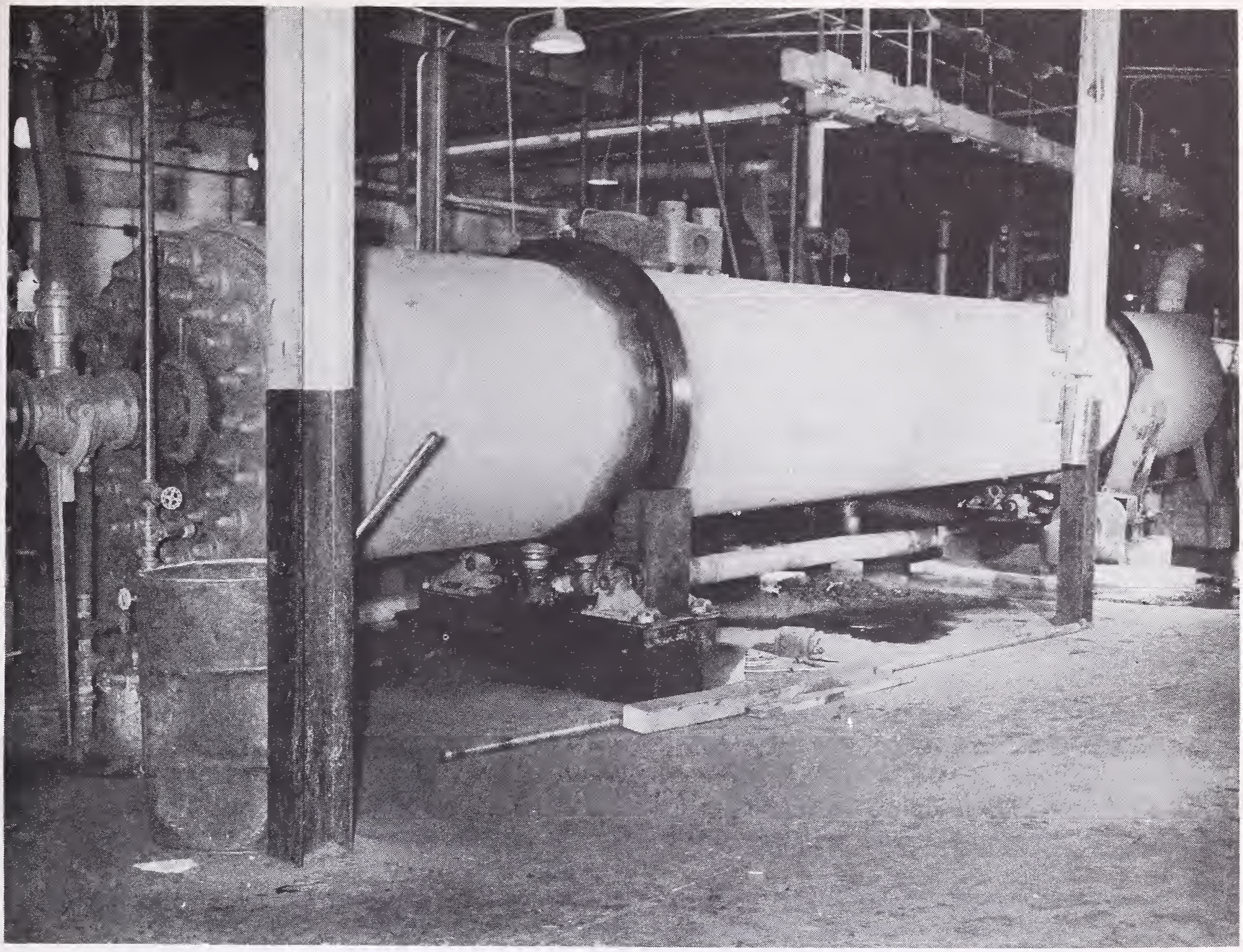
During wartime, the demand for feathers as a filler material in sleeping bags may be enhanced as supplies of wool and other such materials become scarce. The down from ducks and geese excels chicken feathers in fluffability, which is the capacity to regain their original bulk properties when subjected to a simple beating or fluffing process. This permits them to be compressed for storage and then re-fluffed to provide the needed bulk for filler material in a sleeping bag. Chicken feathers require considerable conditioning and sorting for this use. Some improvement in the usefulness of chicken feathers as a substitute for waterfowl feathers can be made by crushing and air separation. The chicken feathers may then serve as a satisfactory replacement for wool in sleeping bags (17).

In their natural form, feathers average 73.2 percent protein and 21.6 percent water, with traces of fat and ash (3).

In preparing feathermeal, wet feathers must be cooked at high pressure, 40 to 60 pounds per square inch (287° to 307°), for 30 to 60 minutes and then dried under a vacuum or in a rotary steamtube drier (fig. 5)(4; 5). This process breaks down the feathers into a granular meal and makes them digestible for feeding to animals. The meal after grinding weighs 52 to 60 pounds per cubic foot. It contains 12.1 to 13.6 percent nitrogen (2).

Feathermeal can be used as either feed or fertilizer. 3/ After additional processing, keratin, a protein substance, becomes available. It can be used as a modifier for phenolic molding powders, as a plaster retarder, as a fire control foam agent, and in the manufacture of construction materials. However, few of these uses are currently feasible, because similar materials are available from other sources at considerably lower costs.

3/ Naber, Edward C. and Morgan, C. L. Feathermeal as a Poultry Feedstuff, Clemson Agr. College, Clemson, S. C., 1955; and Romoser, G. Lynn Studies on Feathermeal and Poultry Byproducts Meal in Broiler Rations, Unpublished data extracted from Proceedings of the University of Maryland Nutrition Conference for Feed Manufacturers, March 17 and 18, 1955. [Processed]



N-15923

Figure 5.--Type of drier used for feathermeal.

Nutritive value of feathermeal limited

Reports regarding the nutritive value of feathermeal are inconclusive because of the small number of feeding trials upon which they are based. Data contained in available reports suggest the following: 4/

"1. When feathermeal at levels of 2 to 5 percent replaced corresponding quantities of soybean meal in a basal diet, about the same growth was obtained.

4/ This evaluation was prepared in 1955 by Charles A. Denton, Poultry Nutrition Investigations, ARS, USDA, Beltsville, Md. Materials available to him included reports prepared by Gerald F. Combs, professor of nutrition, Univ. of Md.; O. H. M. Wilder, biochemist, American Meat Institute Foundation, Univ. of Chicago; Edward C. Naber and C. L. Morgan, Clemson Agr. College; E. L. Stevenson, associate professor of nutrition, Univ. of Ark.; and A. A. Camp, Texas Agr. Expt. Sta., Station No. 21, Gonzales, Texas.

"2. When feathermeal was added to a low-protein diet, optimum response was not obtained without proper amino acid supplementation.

"3. When a diet, adequate in protein and amino acids, was supplemented with 2 to 4 percent feathermeal, there were indications that a growth response may be obtained.

"4. Since feathermeal appears to be deficient in several essential amino acids, its classification as a protein concentrate is questionable.

"5. The feathermeals tested do not appear to be well standardized products, as different meals in the hands of the same investigator give different results. This, of course, may be due to biological variation. However, a thorough study of the biological effect of meals from different processing procedures should be made."

Results of the field survey of rendering plants show that feathermeal yields range from 20 to 35 percent of the weight of wet feathers delivered by the poultry processor. Six of the 10 plants reporting obtained yields of 25 percent.

Yields are greatly affected by the moisture content of the feathers, which may be as high as 70 to 80 percent as the feathers come from slaughtering plants. The moisture content can be reduced by both draining and baling. Although baling eliminates the need for containers, it does not reduce the perishability of feathers prior to being processed.

In 1955, feathermeal sold at prices comparable to prices for other sources of organic nitrogen. The most frequently reported price was $65 per ton. Six of the 10 feather renderers visited reported sales of feathermeal to fertilizer companies. The other companies sold feathermeal to mixed feed processors, who used it as a high-protein feed constituent.

BYPRODUCTS FROM POULTRY EVISCERATION

The recent trend toward complete evisceration of poultry has intensified the problem of byproduct utilization. Offal was formerly discarded by local butchers or housewives in small quantities and at widely separated points, but it is now accumulated in substantial quantities at slaughtering plants. It represents an added source of income or expense, depending upon how it is used. Ninety-one percent of the slaughterers sampled in the United States eviscerate poultry (table 4).

New York dressed poultry is continuing to decline in popularity. The last major stronghold of New York dressed poultry is in the New England States, where almost two-thirds of the slaughterers contacted sold poultry in that form. However, there were several plants in the region which bought New York dressed poultry and completed the eviscerating process.

Table 4.--Sampled plants eviscerating poultry, by region, U. S., 1955.

Region	Plants sampled in area	Plants reported eviscerating	
	Number	Number	Percent
New England	29	11	38
Middle Atlantic ...	17	16	94
East North Central.	50	50	100
West North Central.	58	56	97
South Atlantic	89	80	90
East South Central.	12	12	100
West South Central.	48	48	100
Mountain	5	5	100
Pacific	35	35	100
United States ...	343	313	91

Methods of handling offal in eviscerating rooms depend on such factors as size of plant, outlet used, and in-plant facilities available. Viscera are removed from the birds and allowed to fall into a trough, or, where inspection is involved, onto a moving belt or pan, and discharged at the end of the eviscerating table into drums or a flow-away system. Giblets can be removed before the viscera are separated from the bird (fig. 6) or after being deposited on the moving belt or pan. Most plants collect offal in drums in which it is transported to renderers (table 5). A few plants use flow-away systems, which move offal through troughs filled with water and discharge it through a rotary screen where the free water is removed. The flow-away system lends itself to bulk handling but may also be used with drums (fig. 7). With this system, viscera and heads are combined but feet are usually collected manually.

Table 5.--Poultry eviscerating plants quoting prices received for offal, by size of plant, U. S., 1955.

Size of plant by volume of slaughter per week	Distribution of eviscerating plants by size	Plants in each size group quoting a price received
Thousand pounds	Percent	Percent
Under 30	43	15
30 - 99	23	25
100 - 299	22	67
300 and over	12	64
All plants	100	34

Figure 6.--Separating giblets. N-15930

Figure 7.--Collecting offal at a rotary screen. N-15927

Heads are either removed by hand, as is the case with turkeys or pulled from the birds as the heads pass over a V-shaped notch, as is the case with smaller birds. Feet are removed by hand from birds hanging by their heads, and birds hanging head down are cut from the feet. In the latter instance, the feet are removed from the line before they reach the hanging area. In either case, the feet are usually kept separate until they reach the offal room. Yields of heads, feet, and viscera vary depending upon class of poultry, breed, age, and finish (appendix, page 48). For turkeys it may be less than 15 percent of the live weight. For broilers, yields usually exceed 20 percent.

Renderers are principal outlet for large plants

Large slaughterers tend to prefer renderers as offal outlets, because of the relatively large quantities which they can regularly handle. Renderers, in turn, usually prefer to collect offal and other byproducts from large slaughtering plants so that they can minimize their assembly costs. They usually furnish containers and collect offal at the slaughtering plant. This type of outlet received offal from more than half of the poultry slaughtering plants visited in 1955.

Here again, proximity to the renderer or to an offal pickup route, plus the volume available, are important factors in determining what, if any, price the renderer will pay for raw offal. Of all eviscerating plants contacted in 1955, about one-third quoted prices received for offal. About two-thirds of the plants slaughtering 100,000 or more pounds per week quoted prices received for offal, whereas less than one-fifth of the plants of smaller size mentioned receiving any payment (table 6).

Farmers are an important outlet for offal from small slaughterers, especially those slaughtering less than 30,000 pounds per week (table 6). Most of the larger slaughterers feel that farmers cannot be relied on as regular outlets for offal. Few farmers can handle large volumes, but many are competitive with renderers in seeking poultry offal in some areas.

There are thousands of hog farmers who might well use poultry offal to provide the necessary protein supplement for their grain or to replace the feeding of common garbage. Slaughterers who own hogs are in a position to utilize the value from poultry offal. This material can be profitably fed directly to hogs if (1) the hog farm is located near the slaughtering plant, (2) the daily supply of offal is relatively constant, and (3) the hog operation is of adequate size to justify daily hauling and cooking. In general, these conditions tend to limit profitable hog feeding operations to the smaller slaughterers.

Table 6.--Offal disposal outlets and handling practices in poultry slaughtering plants, by type of area and size of plant, U. S., 1955.

Type of area and size of plant by volume of slaughter per week	Total	In-plant handling		Outlets used for offal			Out of plant handling		
							Outlet collects		Plant delivers
		Manual	Flow away	Renderers	Farmers	Dump	In bulk	In drums	
Thousand pounds	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Commercial									
Under 30	-	-	-	-	-	-	-	-	-
30 - 99	100	100	-	100	-	-	-	75	25
100 - 299	100	93	7	100	-	-	-	100	-
300 and over ...	100	72	28	94	6	-	6	94	-
Total	100	80	20	96	4	-	4	94	2
Noncommercial									
Under 30	100	95	5	39	25	36	6	43	51
30 - 99	100	86	14	69	19	12	14	60	26
100 - 299	100	88	12	82	11	7	4	82	14
300 and over ...	100	82	18	73	23	4	18	68	14
Total	100	90	10	58	21	21	8	58	34
Total									
Under 30	100	95	5	39	25	36	6	43	51
30 - 99	100	86	14	70	19	11	14	60	26
100 - 299	100	88	12	83	10	7	4	83	13
300 and over ...	100	79	21	79	18	3	15	75	10
Total	100	89	11	60	20	20	8	60	32

Cooking is required for hog feeding

Cooking of poultry offal for feeding is desirable, and it is required by law in many States. Cooked offal has the advantage of being sterile, as well as palatable and nutritious for hogs. Nevertheless, offal must be handled promptly, even when cooked, and the operation must be made sanitary. This requires special feeding floors and facilities for cooking, which in turn require special capital investments.

Poultry offal can be used also as feed for domestically grown fur-bearing animals, such as mink. In 1940, for example, there were nearly 3,000 fur farmers located primarily in the northern States. In these States, commercial poultry production is only moderately concentrated, and local slaughterers often need outlets for poultry offal. Mink growers offer a good outlet, since they can accept frequent deliveries of small quantities of poultry offal, or, in some cases, of substantial quantities of the frozen product. Poultry offal replaces horsemeat or other types of animal products, and therefore commands a price which may justify freezing and special handling. These outlets do not, however, accept feathers, manure, or blood. For this reason, returns must usually cover costs of disposing of the unwanted byproducts if the slaughterer is to benefit from grinding and freezing the offal. This treatment insures freshness and results in a product which can be accumulated for movement in truck lots. The frozen offal does not freezer burn or become rancid or yellow if in storage only a short time (29).

Poultry offal has proved to be an excellent diet ingredient for mink because it is palatable and promotes early growth (22). In feeding mink, care should be taken to exclude birds which have been treated with hormones, because of the danger of causing sterility. Cooking may be worthwhile if there is danger of salmonella (27). However, this is not believed to be a serious problem if the material is procured while fresh, immediately processed, properly refrigerated, and thawed just before use. Data regarding mink feeding practices are available. 5/

Poultry offal may be used also as a substitute for horsemeat in feeding dogs and cats. A blend of washed abdominal viscera and thoracic organs together with heads and a portion of the feet and legs, when added to a good basal ration of baked biscuit, kennel meal, or pellets, results in a palatable, nutritious feed providing proteins, fats, and minerals to pets or fur-bearing animals (28). In a few instances, pet food is being manufactured from poultry byproducts for general distribution in canned form.

Fish hatcheries are an outlet for limited quantities of fresh or frozen poultry offal. They are satisfactory outlets only for small plants, since few hatcheries consume more than a ton of food per day. For best results, poultry offal should be made available in relatively uniform quantities. The demand for poultry offal for fish hatcheries is currently limited, because

---

5/ From the Agricultural Research Service, USDA, Beltsville, Md.

their number is small--perhaps 600 nationally--and the supply of competing feed is ample. Beef liver is the favorite food in most hatcheries. 6/ The use of this food is relatively well understood by hatcherymen, whereas use of poultry offal is not. Additional information is needed on its value for feeding fish and on preferred methods of feeding.

Fur farmers are highest paying offal outlets

Hog farmers, fur ranchers, and fish hatcheries, when available, may constitute more profitable outlets per pound for poultry offal than the average rendering plant. In many cases, the farmers collect viscera at the slaughtering plant and pay prices which equal or exceed those paid by renderers.

Payments made by rendering companies, hog farmers, and other buyers varied in 1955 from 10 to 65 cents per hundredweight for raw offal (table 7). A few slaughterers who sold offal to fur farmers received 75 cents or more per hundredweight for select offal, consisting of heads and feet from poultry free from hormone treatment. Much of the offal sold to fur farmers is frozen.

Table 7.--Prices received for offal by poultry slaughtering plants, U.S.,1955

Prices	Plants reporting
Cents per cwt.	Number
0 - 24	28
25 - 49	55
50 - 74	28
75 and over 1/	11
Total	122

1/ Sales to fur farmers.

In contrast, slaughterers who have offal removed to town dumps or municipal incinerators pay the disposal costs. These costs, as reported by some plants, ranged from about 12 to 30 cents per hundredweight.

The processing of poultry offal by renderers involves cooking, to soften the bones and break down the animal tissue; pressing, to remove grease; grinding, to break up or pulverize the resulting cake; and bagging for sale

6/ Tunison, A. V. Trout Feeds and Feeding. U. S. Dept. of Interior, Fish and Wildlife Service, Washington, D. C., mimeo rev. February 1945.

to feed mills (figs. 8 and 9). The grease, which is obtained during the pressing operation, is conveyed into drums or tanks where it is held until sold.

The grease from poultry offal generally is darker and of lower grade than grease obtained from beef, mutton, or pork. Most renderers who process large quantities of poultry offal keep it separate from other animal products. This facilitates the separation of relatively low-valued poultry grease from more valuable greases of other animal products, and the adaptation of cooking temperatures and times to poultry offal.

Yields of meat scrap vary mostly from 20 to 25 percent of the orginal weight of the raw poultry offal (table 8). Yields of grease range mostly from 4 to 8 percent. Yields of meat scrap and grease depend largely on the amount of moisture in the raw product as it is put into the cooker. A considerable variation in grease yields is accounted for also by the maturity of the poultry being handled. Large amounts of fat are obtained from heavy fowl, whereas the quantity of fat from broilers is quite small.

Table 8.--Rendering plant yields of grease and cracklings from poultry by-products, U. S., 1955.

Grease		Cracklings	
Number of plants reporting	Percent yield	Number of plants reporting	Percent yield
1	Under 4	0	Under 15
15	4.1 - 8	3	15 - 19.9
7	8.1 - 12	12	20 - 24.9
3	12.1 - 16	6	25 - 29.9
3	Over 16	2	30 - 34.9
		2	35 - 39.9
		1	40 and over
29	Total plants reporting	26	Total plants reporting

Prices for poultry byproduct meal and grease depend on prices for comparable materials.

Poultry byproduct meal is usually disposed of through mixed feed processors, farmers, or grain dealers. Renderers receive prices which range from $60 to $125 per ton, depending upon their location in relation to primary sources of similar materials, or in relation to principal consuming markets. The most frequently reported prices in 1955 ranged from $80 to $90 per ton. There is a wide annual variation in prices because of variations in prices of other high-protein feeds (fig. 10).

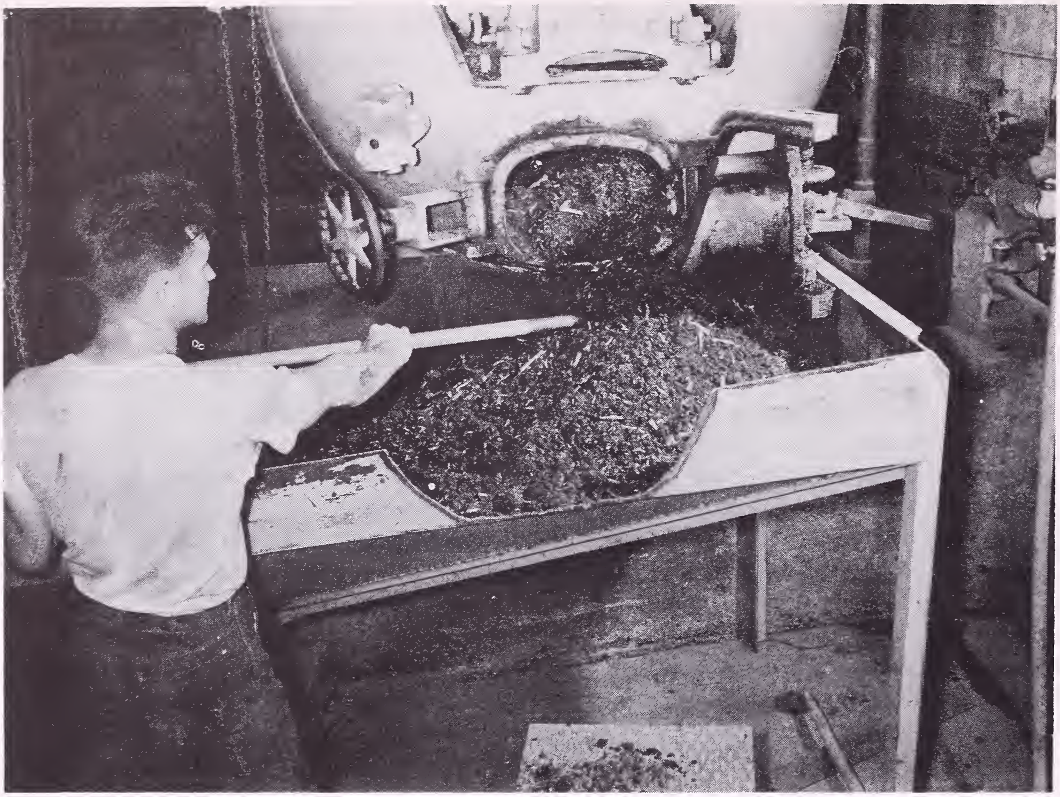


Figure 8.--Removing offal from cooker. N-15921

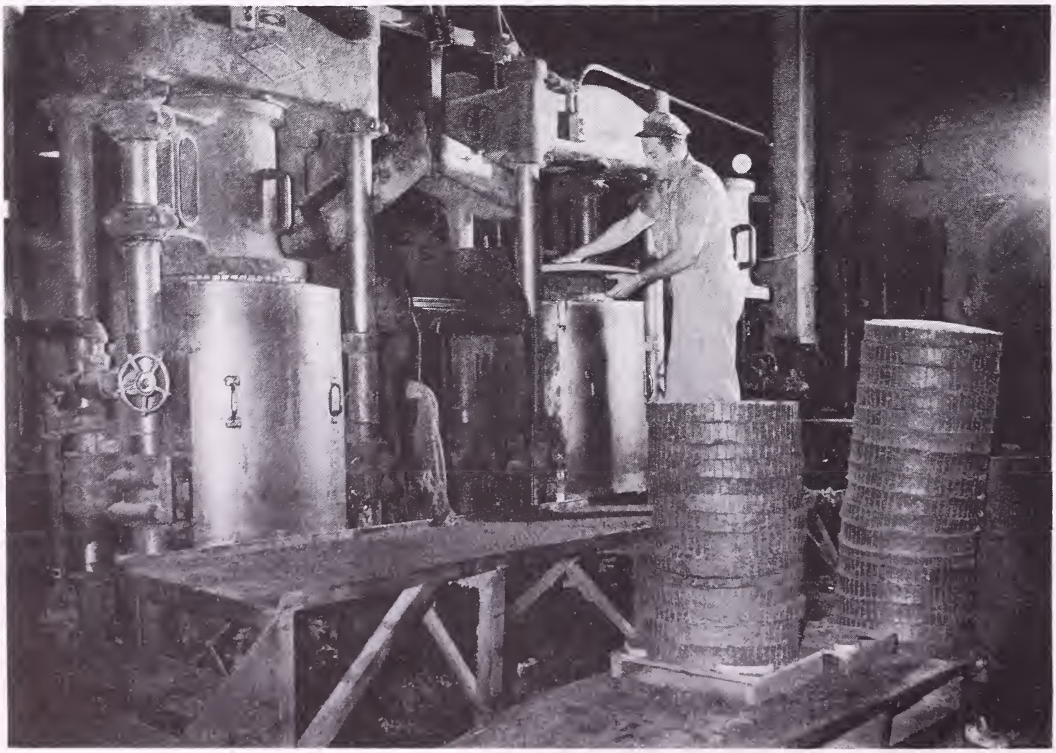


Figure 9.--Removing pressed cake from hydraulic press. N-15922

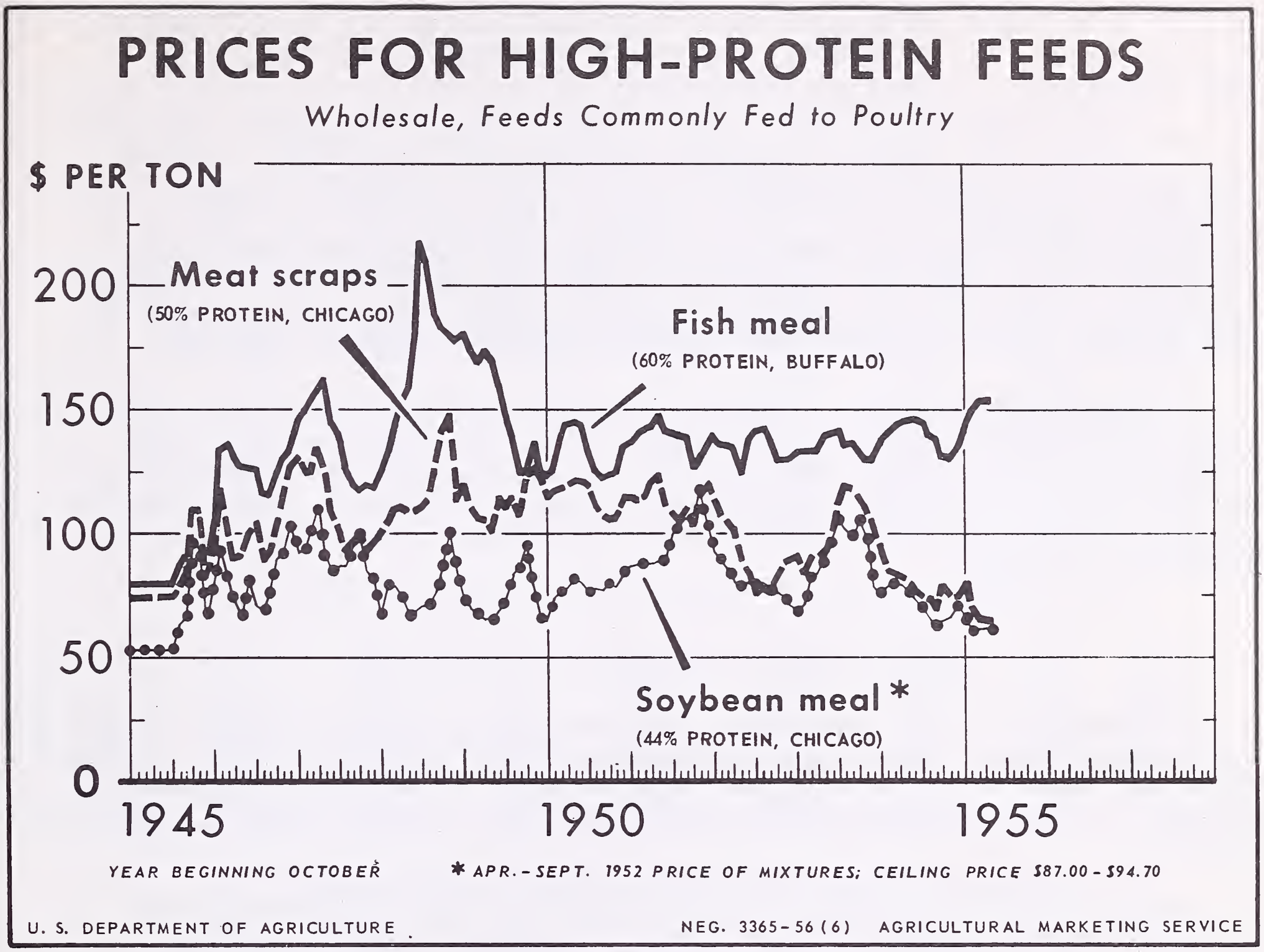


Figure 10.--Prices received for poultry byproducts fluctuate with prices paid for other high protein feeds.

Grease obtained from the rendering of poultry products is used by soap manufacturers, mixed feed manufacturers, lubricating grease manufacturers, and others. Prices range from 3.0 to 7.4 cents per pound, depending upon the grade of the grease. The most frequently reported prices were 6.0 to 6.5 cents per pound.

BLOOD, FEATHERS, AND OFFAL COMBINED AS FEED SUPPLEMENT

Renderers generally believe that feathers should be kept out of offal because offal then becomes more difficult to render. There is also some objection in the feed trade to traces of feathers in poultry cracklings even though they do impart a high protein value. This objection has been of some concern to renderers since it is not easy to exclude all traces of feathers from finished products.

Mixture may be more nutritious

It is possible to cook combinations of blood, feathers, and offal. In theory, this would result in a more complete protein feed. This seems to be borne out by preliminary feeding trials with poultry which show that a sample of poultry byproduct feed consisting of blood, feathers, and offal in their natural proportions is a useful protein supplement when substituted for 30 percent of the vegetable protein. The combined poultry byproduct feed has a marked superiority over straight feathermeal when used as a supplement to the basal broiler ration. These trials also show that the addition of animal grease will increase rates of gain of meat birds and reduce the feed required per pound of gain. 7/

Combined cooking might eliminate separate facilities for feather and offal rendering and simplify processing. This would be possible if the cooking and drying process were satisfactorily completed in a cooker without an additional drier. The elimination of an additional drier would permit a sizable reduction in fixed costs, because investment in equipment could be materially reduced.

LIMITATIONS ON UTILIZATION OF BYPRODUCTS

Commercial poultry slaughterers operate in many types of urban as well as rural communities. Some large slaughtering plants serve wide areas. Table 9 gives the distribution of slaughtering plants and of poultry slaughtered by regions. A more detailed picture of the location of these plants is given in fig. 11.

Where poultry production is ample, there may be a concentration of poultry slaughtering plants, and adequate rendering facilities may be available for processing blood, feathers, and offal. In areas of concentrated production, such as north Georgia, Delmarva, Shenandoah Valley, and northwest Arkansas, large rendering firms handling poultry byproducts are well established and competition among them is vigorous.

Where plants are isolated, facilities for complete utilization of byproducts usually are not adequate. Poultry slaughterers often rely on renderers who serve butcher shops, pick up dead animals, and collect from local abattoirs or locker plants. These renderers seldom find it profitable to keep poultry offal separate from other animal products, and seldom utilize blood or feathers. More than half of the poultry plants visited in commercial areas reported sales of byproducts. In noncommercial areas, almost one-third of the plants reported sales of offal, but only 11 percent reported sales of feathers.

7/ Reports of feed trials conducted by G. Lynn Romoser, assistant professor of poultry nutrition at the University of Maryland, 1955; and Edward C. Naber, assistant poultry nutritionist at Clemson Agricultural College, Clemson, S. C., March 26, 1956.

Table 9.--Geographic distribution of commercial poultry slaughter plants and volume of slaughter, by size of plant, U. S., January 1, 1956.

Region	Number of plants by sizes				Total pounds slaughtered per week by size groups			
	30,000 to 99,999 1/	100,000 to 299,999	Over 300,000	All plants	30,000 to 99,999	100,000 to 299,999	Over 300,000	All plants
	Number	Number	Number	Number	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
N. Atl. ..	61	28	10	99	2,883	5,675	4,327	12,885
E.N.C. ...	55	29	3	87	2,725	4,310	1,282	8,317
W.N.C. ...	97	55	7	159	4,627	8,561	2,580	15,768
S.A.	40	42	34	116	2,093	7,737	16,816	26,646
S. Cent. .	59	50	12	121	3,275	8,372	4,929	16,576
West	49	25	8	82	2,637	4,266	3,770	10,673
U.S.	316	229	74	664	18,240	38,921	33,704	90,865
	Distribution of United States total within regions							
N. Atl. ..	61.6	28.3	10.1	100.0	22.4	44.0	33.6	100.0
E.N.C. ...	63.2	33.3	3.5	100.0	32.8	51.8	15.4	100.0
W.N.C. ...	61.0	34.6	4.4	100.0	29.3	54.3	16.4	100.0
S.A.	34.5	36.2	29.3	100.0	7.9	29.0	63.1	100.0
S. Cent. .	48.8	41.3	9.9	100.0	19.8	50.5	29.7	100.0
West	59.8	30.4	9.8	100.0	24.7	40.0	35.3	100.0
U.S.	54.4	34.5	11.1	100.0	20.1	42.8	37.1	100.0
	Distribution of United States total within size groups							
N. Atl. ..	16.9	12.2	13.5	14.9	15.8	14.6	12.8	14.2
E.N.C. ...	15.2	12.7	4.1	13.1	14.9	11.1	3.8	9.2
W.N.C. ...	26.9	24.0	9.5	23.9	25.4	22.0	7.7	17.4
S.A.	11.1	18.4	45.9	17.5	11.5	19.9	49.9	29.3
S. Cent. .	16.3	21.8	16.2	8.2	17.9	21.5	14.6	18.2
West	13.6	10.9	10.8	12.4	14.5	10.9	11.2	11.7
U.S.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Live weight of slaughter per week.

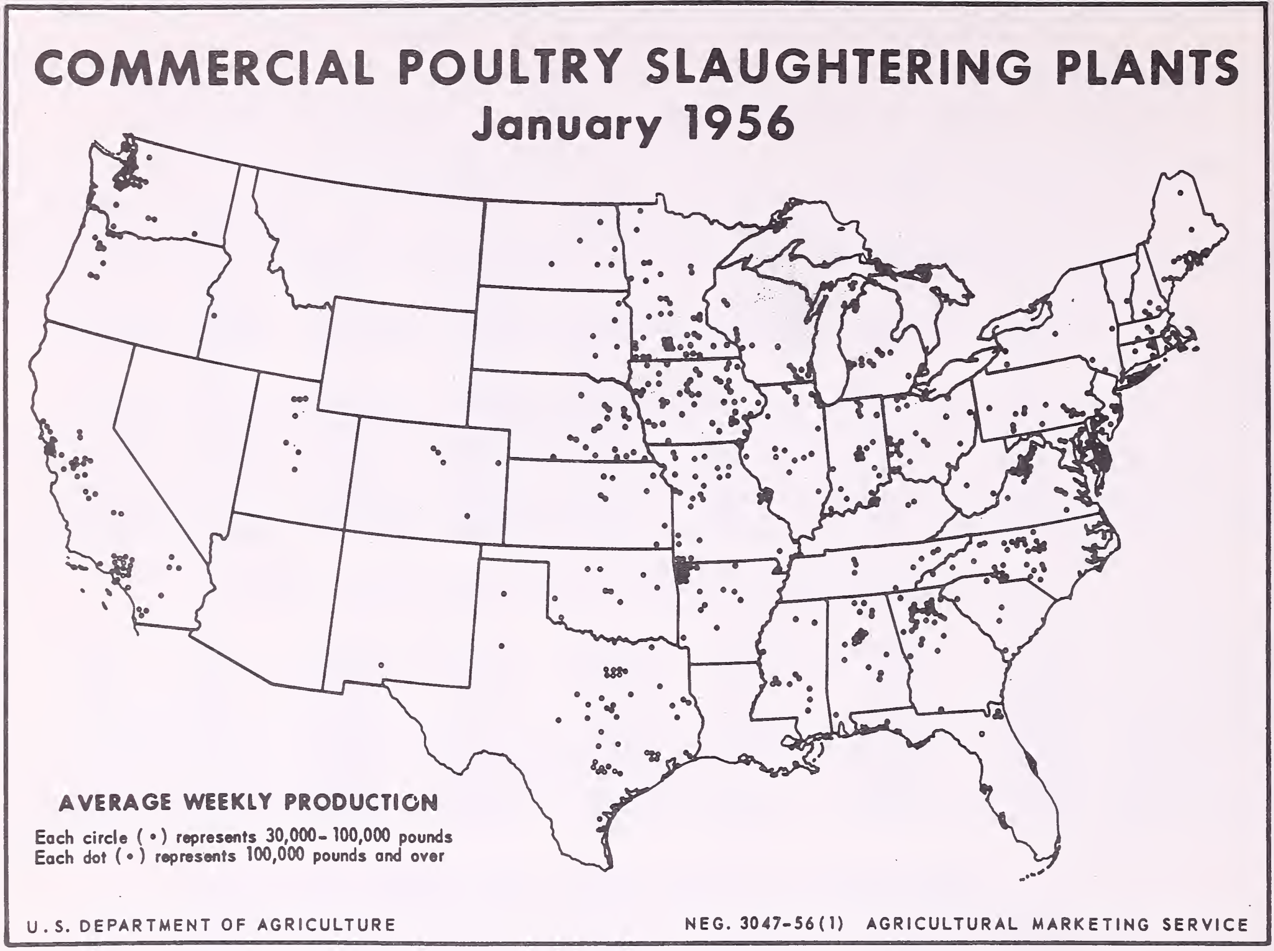


Figure 11.--Commercial poultry slaughtering plants are usually located in poultry producing areas.

Renderers who used their own trucks or used custom truckers for picking up poultry byproducts reported maximum pickup radii from their plants of from 25 to 162 miles. The most frequently reported maximum radius was 50 miles. The minimum volume required per stop varies considerably, depending largely on the location of the processor. A reasonable figure quoted as a minimum volume of pickup per maximum distance was 100 pounds per extra mile beyond 50 miles. A processor with a small volume of poultry byproducts might be serviced by a renderer if he were on an established collection route or close to the rendering plant. Otherwise, daily removal might handicap a plant whose volume of accumulated unprocessed supplies is not enough for a full truckload. Partial truckloads contribute to high costs of assembly.

Slaughterers not now taking advantage of an available renderer should consider the renderer as a possible outlet. Even if the renderer does not pay for the product, but picks it up at his own expense, he certainly would be an alternative preferable to paying to have the byproducts removed.

State and local ordinances may affect byproduct utilization

Most local health departments and State and Federal inspection services require daily removal of all raw byproducts from slaughtering plant premises. Special rooms and other facilities must be provided at some plants for storing the daily accumulation because of the perishability and objectionable characteristics of wet feathers and raw offal. In some States, special permits are required for garbage cooking or for rendering. In some instances regulations also affect the marketing of the processed byproducts by requiring special labeling or prescribing the manner in which various byproducts are combined. For example, poultry cracklings with traces of feathers included are frowned upon in some States, and such cracklings are penalized when priced.

Yields of poultry byproduct meal and feathermeal in relation to raw poultry offal and feathers are low, 20 to 30 percent for most rendering plants. If inedible poultry byproducts are to be profitably salvaged in specilized rendering plants, large tonnages of raw materials must be readily available at all times. A ton of poultry byproduct meal requires nearly 4 tons of raw offal or 20 tons of live poultry. For this reason, large specialized poultry byproduct renderers must be located in or near areas of concentrated production to permit maximum efficiency in procuring and processing raw materials.

Maximum efficiency is attainable when a plant can operate at or near its capacity, which should equal its peak load. Renderers are interested in continuous daily volumes sufficient to keep their plants and crews busy, but they should have a labor force adequate to handle peak loads. Although renderers want consistent volumes of raw materials, daily and weekly variations in supply are inevitable. Slaughterers generally insist on dependable service on a daily basis.

Slaughtering plants which operate on a seasonal basis often find it difficult to establish satisfactory working relationships with renderers or other outlets. Slaughterers must adjust their operations to their supply of poultry and market outlets. Seasonality of production is especially important in the commercial turkey-producing areas or in areas where farm fowl are marketed in large volume. Seasonal variations in the 1955 slaughter of broilers and turkeys in commercial plants throughout the U. S. are shown in figure 12. Note the relatively even monthly distribution of broilers and the highly seasonal slaughter of turkeys. The variation for individual plants frequently exceeds that of the national average and, where it is excessive, adversely affects opportunities to dispose of inedible products.

The volume of rendered material that will become available from a poultry slaughtering plant can be roughly approximated by assuming that the dried blood, feathermeal, poultry byproduct meal, and grease will equal 10 percent of the live weight of the poultry slaughtered. Actual yields will vary considerably, depending upon the kind and class of poultry, the finish of the birds, and handling practices.

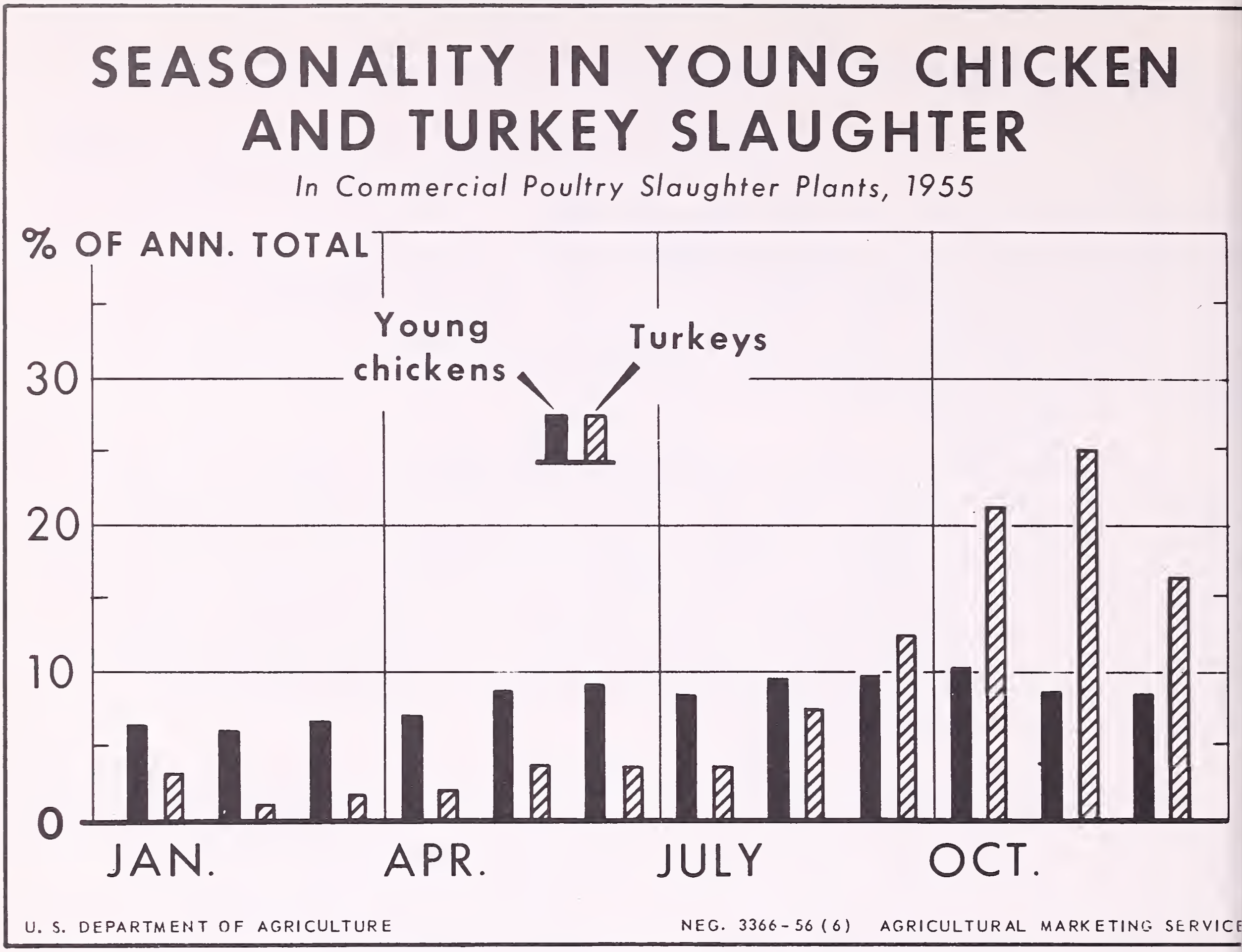


Figure 12.--Seasonal variation in young chicken slaughter is small compared to the variation in turkey slaughter.

Renderers prefer to deal with slaughtering plants which are large enough to enable them to load a truck at a single stop, thereby helping to minimize collection costs. To obtain seasonally large volumes, renderers must obligate themselves to pick up byproducts during periods when production is low, even if such operations are not profitable. Processing on a small scale is expensive. Renderers are given some protection if they have sufficient sources of supply to compensate for individual variations. When this situation does not prevail, renderers sometimes withhold payments to slaughterers to cover fixed costs during the periods of low volume.

Combined costs for assembling and processing inedible poultry products are often large. While rendering plant costs as low as $20 per ton were frequently reported, there were reports of costs as high as $100 per ton in 1955. This range in costs was due to variations in costs of assembly, scale of operations, and fixed overhead.

Fixed capital investment per dollar of sales may be high because of the need for processing equipment, buildings, and land. These combined investments could easily exceed $20,000 for a small firm. Of course, the actual amount invested in a plant would depend upon the age and condition of the equipment and the opportunity to acquire suitable housing at a reasonable price. An adequate rendering operation requires, as a minimum, a steam boiler, one or more cookers, a hydraulic press or other type of fat extractor and, if feathers are to be handled expeditiously, an air drier, a grinder, and various conveyors.

In general, unit values of finished poultry byproducts are relatively low, especially when compared with prices for eviscerated poultry and with some assembly, processing, and overhead costs.

During the 1955 field survey, renderers were asked to list any relatively simple changes in practices of poultry plants which would increase the value of byproducts or reduce costs of handling. The following replies were received:

1. Use a rotary screen or some other method to keep the water content of offal to a mimimum.

2. Keep feathers out of offal.

3. Keep crops and gizzard contents separate.

4. Clean viscera to remove impurities (grit, wood, fiber, etc.).

5. Bale feathers to reduce moisture content and reduce cooking time.

6. Fill drums properly and provide a more uniform daily volume.

7. Use bulk handling methods and increase mechanization if volume is great enough.

8. Provide elevators and loading devices.

9. Use a chemical in drums to help keep down obnoxious odor in summer.

10. Install hoppers so that material from one or more small plants can be held longer and a pickup truck can get a full load at a single stop.

11. Operate poultry plants more regularly.

Rendered poultry byproducts tend to remain relatively low in unit value because their prices, in general, cannot deviate greatly from prices of competitive products. Inedible byproducts from poultry slaughter and evisceration are sold in competition with products from other sources for their major uses. Poultry by-product meal does not suffer from important amino acid deficiencies and can therefore substitute for other animal protein supplements in feeds. Feather meal is deficient in certain essential

amino acids and will only give good results as a protein feed supplement in combination with animal proteins or amino acids which will compensate for the deficiencies. In general, feathermeal can substitute for the vegetable protein. Feathers as a filling material compete with synthetic materials such as foam rubber and rubberized hair.

In spite of the tested values, a great deal of promotion is necessary to sell poultry byproducts. Prospective buyers must be convinced that these materials are as valuable as similar products from other sources, and that prices are competitive.

NEED FOR RESEARCH ON BYPRODUCT UTILIZATION

Questions on costs of and returns from poultry byproduct utilization can be answered by slaughterers who sell byproducts to local renderers, but data are not available for slaughterers who may wish to evaluate possibilities of doing their own processing. Research is needed to determine plant costs and input-output relationships of labor, capital, equipment and materials, as affected by size of plant. Data are needed also on returns for processing inedible poultry byproducts into various feed supplements and other useful products as a continuation of poultry plant slaughtering operations. Consideration should be given to the possibility of reducing costs by combining blood, feathers, and offal into one cook. 8/

Research is needed to develop more efficient methods of collecting and handling inedible byproducts from the dressing and evisceration processes. This might involve such things as mechanical conveyors, rotary screens, and bulk storage. 9/

Additional research is needed to develop optimum processing techniques with respect to cooking time, temperatures, pressures, and drying practices, and to determine effects of variations in these factors on nutritive values. This research should deal with the processing of blood, feathers, and offal separately and in combination. Consideration must be given to fat stabilization through the addition of antioxidants. 10/

8/ Research in this field was initiated by the USDA on January 30, 1956, when it contracted with the Battelle Memorial Institute, a private research agency, to investigate the feasibility of integrating byproduct processing with poultry slaughtering operations.

9/ The Transportation and Facilities Branch, Marketing Research Division, AMS, USDA, plans work in this field.

10/ The Western Utilization Research Branch, Albany, Calif., in cooperation with several experiment stations, is conducting research on the effect of variations in processing procedures on the availability of amino acids and growth factors in feathermeal.

Feeding values must be demonstrated

While feed values of feathermeal are being rather thoroughly investigated, little work is being done on feed values of poultry meat scrap meal. If maximum use is to be made of the processed materials, feeding trials must be made to determine relative values of bloodmeal, feathermeal, poultry byproduct meal, and poultry fat as feed components, and to establish comparative values for a combination of these products in their natural proportions. Trials should be conducted experimentally and on a commercial scale. 11/

If byproducts from all classes of poultry are to be utilized, information must be obtained regarding relative yields of bloodmeal, feathermeal, poultry byproduct meal, and grease from various weights and classes of poultry, and the chemical composition of these finished byproducts. This is needed to establish the range in the protein content one might encounter in comparing products from various classes and weights of poultry, and in determining the significance of such variations to the feed manufacturer. Such information is needed to determine whether byproducts from various classes of poultry can be commingled without regard to the proportions of each or whether some standardization is needed.

Existing equipment appears to be feasible only where a large volume of byproducts is available. Research is needed to develop equipment which will remove the moisture from small lots of poultry byproducts and convert them into storable form. Perhaps a small cooker, which could process and dry the combined inedible products in one operation with no fat extraction or other treatment, would suffice for small-scale operations. Reasonable capital investment and operating costs must be achieved.

The development of feasible methods of processing poultry byproducts will create a need for expanded markets and for research designed to locate new and expanded uses for poultry byproducts. Information is needed regarding means of improving the acceptability of the product to feed manufacturers and other prospective buyers. Currently, some feathermeal and bloodmeal are being used as fertilizers. Opportunities for expanding such uses should be explored.

Poultry offal can be fed in its raw form or with just enough cooking to sterilize it. Research is needed to establish proper methods of handling and feeding, as well as feeding rates. The feasibility of freezing or cooking offal with grain should be investigated as measures which result in increased storage life. It is especially important that techniques be developed for storing the product so that full truckloads can be accumulated, or so that a load can be held for orderly feeding.

11/ Preliminary feeding tests of poultry byproducts are currently being conducted throughout the United States. See appendix, page 49.

ACCUMULATION AND DISPOSITION OF MANURE

For every pound of feed consumed by poultry, approximately 2 pounds of manure become available. Fresh poultry droppings as they are voided have a moisture content of about 60 to 75 percent. Manure found in feeding rooms of slaughtering plants probably has a higher moisture content because feeding practices are conducive to a high water intake. The addition of water to this fresh manure, which occurs when batteries are washed, results in a slurry of relatively low value, and costs of hauling and spreading may exceed the fertilizing value. If the batteries are scraped, however, a relatively solid material of appreciable fertilizing value results.

There has been a trend, especially in the commercial broiler areas, away from the holding and feeding of live poultry. Many plants transfer incoming birds to killing lines directly from assembly trucks. As a result, these plants handle practically no manure and eliminate this disposal problem.

A limited volume of manure was recovered from 289 of the poultry slaughtering plants visited (table 10). Eighty-four percent of the plants handled manure by scraping down the battery pans (fig. 13). The remaining plants handled manure by washing down the battery area.

Table 10.--Disposition and handling of manure in poultry slaughtering plants, by size of plant, U. S., 1955.

Size of plant by volume of slaughter per week	Plants handling manure	Practices followed in plants handling manure					
		In-plant handling		Outlets used for manure			
		Scraping down	Washing	Farmers	Dump	Drain	Renderer
Thousand pounds	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Under 30	87	86	14	38	46	10	6
30 - 99	82	87	13	47	26	9	18
100 - 299 ...	76	79	21	47	25	20	8
300 and over.	80	82	18	53	23	12	12
All plants.	83	84	16	44	34	12	10

When material was accumulated in concentrated form, its value was higher and some recovery of collection costs became more feasible. The dollar value of the available manure was small, however, in relation to the labor cost involved in its collection and removal. Only 4 plants reported receiving any net income from manure, although 20 percent of the plants had manure removed from plant premises without cost to the plant.

N-15924

Figure 13.--Scraping manure.

Local farmers utilized the manure from almost half of the plants visited. Thirty-four percent of the plants disposed of manure through town dumps, and 10 percent to rendering companies. Collection and removal costs prompted 12 percent of the slaughterers to dispose of manure by washing it into sewers. Where washing into sewers occurred, manure recovery by use of settling tanks or screens is the only recovery method and it is justified to prevent stream pollution rather than to recover a valuable byproduct. Liquid manure was usually disposed of at the slaughterer's expense.

WASTE WATER DISPOSAL OR TREATMENT [12]

Problems of Sewage Disposal

Water in large quantities is essential to the processing of poultry. It is used for scalding before the removal of feathers, for cooking, and in some plants as a means of moving inedible portions away from the evisceration area. At the end of each working period, it is used to clean the equipment and premises. About one gallon of water per pound of live poultry slaughtered may be used, and with a daily slaughter of 75,000 to 100,000 pounds or more, the volume of water to be disposed of can be quite large.

Waste water from poultry slaughtering plants contains various quantities of manure, blood, feathers, fleshings, and other organic material. Its actual composition depends, first, upon the organic material which is included, and second, upon the amount of water with which this material is diluted. Generally speaking, the sewage from poultry processing plants is similar to domestic sewage and it can create similar treatment or disposal problems. With good management, waste water from the slaughter of 1,000 birds can be no more troublesome than the domestic sewage from 150 people. However, when blood or manure is included in the waste water, it may be equivalent to the sewage from as many as 600 people.

Strength of waste depends on plant practices

The strength of waste water from poultry processing plants, in terms of its solids content and BOD [13], depends upon the waste materials which go into the sewers. Some plants use sewers only for water used in the dressing and eviscerating operations. They include no blood or manure except for small amounts flushed into drains during clean-up periods. Many plants include blood in sewage, and a few plants include manure, or both manure and blood, but this practice is decreasing (table 11).

When both blood and manure are excluded from sewers, stream pollution is held to a minimum. Estimates of the strength of various kinds of sewage believed to be typical of many plants are given in table 12. These estimates show how important it is to keep blood and manure out of the sewer to minimize the BOD and the suspended solids content of the sewage. Over 40 percent of the plants included blood in sewage, but relatively few added manure.

12/ Based on An Economic Analysis of Treatment or Disposal of Poultry Dressing Waste Waters, by Professor R. Rupert Kountz, College of Engineering, Pennsylvania State University, University Park, Pa., assisted by graduate assistants John M. Allen and Donald R. Vaughn.

13/ BOD is the abbreviation for biochemical oxygen demand. This value is the amount of oxygen required to decompose completely the pollution in the waste water. It is a measure of pollution strength and indirectly of the cost of treating the waste. "Suspended solids" is the solid matter carried along in the waste water. It can be reduced to a low value by good housekeeping and by screening equipment.

Table 11.--Waste content of sewage from sampled poultry slaughtering plants, by region, U. S., 1955.

Region	Plants sampled	Waste content: Processing water only	Processing and manure	Processing and blood	Processing, manure and blood
	Number	Percent	Percent	Percent	Percent
N.E.	29	55	-	35	10
E.N.C.	50	50	-	48	2
E.S.C.	12	8	-	92	-
W.S.C.	48	27	2	56	15
S. A.	89	51	17	23	9
W.N.C.	58	48	3	45	3
M.A.	17	29	18	47	6
Mt.	5	-	-	100	-
Pac.	35	40	3	57	-
U. S. total..	343	43	7	44	6

Table 12. Strength of sewage from various types of waste materials in poultry processing plants.

Type of waste	Water per 1,000 birds 1/	BOD	Pounds BOD per 1,000 birds
	Pounds	Parts per million	Pounds
A. Processing waste water only	29,000	515	15
B. Blood	150	2/	45
Processing waste including blood	29,150	2,050	60
C. Manure	12,000	2/	75
Processing waste including manure	41,000	2,200	90
D. Processing waste including blood and manure	41,150	3,300	135

1/ One gallon per pound live weight for processing and .4 gallon per pound live weight for washing batteries.

2/ BOD in parts per million not given until waste materials are combined with processing waste water.

In deciding how to dispose of blood and manure, the plant manager must consider three factors. He must consider local health or stream pollution regulations or conditions imposed by local authorities who provide sewer service. In many instances, a plant must exclude blood or manure from the sewage or treat the sewage so that these materials do not pollute the stream or overload the local sewage disposal plant.

Where regulations permit the washing of blood or manure into sewers, plant managers ought to consider whether use of the sewer will be more desirable than other methods of disposal. They should explore opportunities to dispose of these waste materials to nearby farmers or renderers, or compare costs of disposal through a sewer with costs of hauling to a dump or to a recipient's premises.

Where city sewers were available, plants in the 1955 survey used them for large amounts of blood but little manure (table 13). The latter would tend to fill the sewers with sediment.

Table 13.--Relation between available outlets and disposal of manure and blood, by size of plant, U. S., 1955.

Size of plant by volume of slaughter per week	Open stream				Septic tank and drainage field				City sewer			
	Manure		Blood		Manure		Blood		Manure		Blood	
	Saved	Washed	Saved	Washed	Saved	Washed	Saved	Washed	Saved	Washed	Saved	Washed
Thousand pounds	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Under 30..	61	39	49	51	90	10	53	47	87	13	29	71
30 - 99...	70	30	73	27	85	15	63	37	90	10	39	61
100 - 299.	76	24	86	14	87	13	65	45	83	17	47	53
Over 300..	90	10	72	28	1/	1/	1/	1/	72	28	52	48
Total...	75	25	68	32	86	14	57	43	84	16	38	62

1/ Only 5 plants involved.

With septic tanks and drainage fields, less blood was included. 14/ When open streams were available, relatively little blood was washed, especially from the large plants, but the washing of manure was noticeably more frequent. In some plants, however, shaker screens or settling basins were used to remove the heavier particles before release into the stream. When plants following

---

14/ A septic tank is a device to allow the suspended solids to settle out of the waste water. Unless it is unreasonably large, it cannot appreciably change the BOD nor destroy any of the bacteria in the waste.

this practice are excluded from those washing manure, the proportion is reduced to 15 percent, which is comparable to the proportion washing manure into sewers or septic tanks.

The use of a sewer often saves labor in the plant. However, when sewer service charges are based on the BOD or suspended solids content, operating costs increase when the volume of materials carried away in the sewage increases.

Public sewers preferred as an outlet

Poultry slaughterers usually should use public sewers where they are available. As a general rule, this procedure will result in the most benefit for the least cost to the slaughterer. In many cases it is the only feasible method of sewage disposal, since plants located in small towns or cities are usually limited with respect to available land. Sewage is usually discharged into public sewers without treatment other than simple screening. Charges for the use of public sewers vary greatly, depending upon local conditions. In some cities, no special charge is made to poultry plants. In other communities, the charge is in proportion to the volume of water used. In still other localities, sewer charges are based on the nature and strength of the waste flowing from a plant. Where this is the case, pretreatment, as well as good housekeeping practices, are necessary to keep sewer service charges to a minimum.

Nearly one-third of the poultry slaughterers contacted in 1955 required special sewage disposal facilities. Half of this group discharged sewage directly into open streams. The remaining plants used septic tanks, drainage fields, cesspools, or lagoons. Cesspools are leaching pits which permit sewage and waste water to escape into the soil.

The use of an open stream as an outlet for raw, untreated sewage offers an inexpensive method of disposing of processing plant sewage. In most areas, however, this use of open streams is not permitted, because of the burdens it places on the general public. In these and other areas which in the future may be regulated, treatment of sewage must be considered. Treatment consists of two phases: The removal or destruction of suspended solids such as particles of manure, feathers, or fleshings, and the destruction of dissolved organic material such as blood. For the first part of the treatment, a screening, filtering, or settling device is needed. Screens may be floor screens, rotary screens, shaker screens, or fixed screens. Solid material may be removed in large settling chambers. These devices are mechanical. The decomposition of suspended or dissolved organic material, however, involves microorganisms, some of which work in the absence of air (anaerobic bacteria), as is the case in a septic tank, and some of which require oxygen (aerobic bacteria). The latter type of microorganism also requires a moist condition for growth, but it must have oxygen from the atmosphere or from air incorporated in the water in which it lives. For this reason, these bacteria use up the oxygen from streams into which undigested organic material is discharged and, if the volume of waste is large in relation to the volume of water with which it is mixed, a septic condition develops. This condition is harmful to fish and other desirable aquatic life, makes the water unfit for

human use, and creates obnoxious odors.

More poultry slaughter plants in the New England, Middle Atlantic, and South Atlantic States face serious sewage disposal or treatment problems than in other regions. In this area, a relatively high percentage of plants discharge sewage into open streams or private sewage disposal systems (table 14). Forty-five percent of the plants contacted in New England have private sewage disposal systems, which require continual maintenance. Those plants using open streams (35 percent in the South Atlantic region and 24 percent in New England) are confronted with possible requirements for treatment.

Table 14.--Poultry plant sewage disposal practices in various regions of the U. S., 1955.

Region	Plants sampled	Sewage discharged into		
		City sewers	Open streams	Private systems
	Number	Percent	Percent	Percent
N.E.	29	31	24	45
E.N.C.	50	76	12	12
E.S.C.	12	75	-	25
W.S.C.	48	90	-	10
S.A.	89	56	35	9
W.N.C.	58	86	2	12
M.A.	17	65	12	23
Mountain	5	80	-	20
Pacific	35	94	-	6
U. S. total ..	343	72	14	14

Costs of Disposal or Treatment

Waste water can be disposed of through a spray irrigation system or a tile field when a stream or city sewer is not available. Tile field methods require a considerable area of soil, however, and the soil must be permeable and suited to sewage disposal. These systems are designed to distribute the water through a system of pipes so that it can be absorbed into the surrounding soil at a depth of 24 inches below the surface of the ground. While these devices are classed as disposal units rather than treatment plants, the raw sewage is usually decomposed by the action of soil bacteria and pollution is reduced before the water finds its way to underground sources of water supply.

Spray irrigation offers possibility of useful disposal

With a spray irrigation system consisting of conventional agricultural irrigation equipment, a plant might rather quickly set up a disposal system, and maintenance can be simple.

Wide variations in availability and costs of spray irrigation equipment make it difficult to estimate costs. It is estimated, however, that costs might be somewhat as shown in table 15.

Table 15.--Initial investment required and annual operating costs for a spray irrigation system, 1955.

Size of system	Initial investment	Annual operating costs
Gallons per day	Dollars	Dollars
12,500	4,500	3,060
25,000	6,000	3,340
50,000	11,000	4,230
100,000	22,000	6,310

This system has been used successfully with canning plant wastes where there are varying amounts of solid material, but its application to the poultry industry has not been tested. A simple screening device removes solid material too large to pass through the spray nozzles and the remaining organic material is decomposed by soil bacteria. The waste water is disposed of through leaching into the soil, evaporation, or transpiration from vegetation. In some farming areas, some benefits might also be gained from irrigation of crops of pasturage.

In setting up a spray irrigation system, a basic application rate of 10,000 gallons per acre per day is generally considered to be adequate. From 1 to 10 acres would be required for the plants shown. In actual practice, application would be made at up to twice the rate on alternate days to provide a 40-hour resting period. The sump size is designed to hold a 40- to 45-minute accumulation of waste water. The laterals and main lines are sloped so as to drain back to the pump sump when pumping ceases, and thus prevent freezing in winter. It is expected that an icecap will cover the area during severely low temperatures and that this icecap will melt slowly in the warmer weather without objectionable runoff.

Where a spray irrigation system is not practicable, a tile field might be used. This would require soil having a percolation rate of 5 minutes per inch of water for long-time satisfactory operation.

The recommended liquid dosage is one gallon per square foot of trench area per day, if the percolation time for water to fall 1 inch in saturated soil is 5 minutes (see "Individual Sewage Disposal Systems," page 15, reprint

2416, U. S. Public Health Service).

With laterals spaced 10 feet center-to-center and about an acre's dimensions of 218 x 200 feet, 21 laterals could be spaced on each side, giving 42 laterals having a trench width of 3 feet and a length of 100 feet. Such an area of about an acre would handle 12,600 gallons per day, or about 25 percent more than has been assumed for the spray irrigation system. However, if the percolation rate is much above 5 inches per minute, the spray system can handle more sewage.

Costs, per acre of land used, might be somewhat as follows on the basis of 1955 figures:

Excavation for laterals	$ 3,920
Stone for lateral trenches	966
Tile	1,260
Distribution trench	1,121
Sewer line from plant to field	1,500
Dosing syphon	200
Storage chamber for syphon	307
One acre of land	1,000
Labor for laying tile and misc.	726
Total cost per acre	$11,000

If batteries are washed into the system, two additional items must be included:

Shaker screen	$ 700
Sedimentation tank - 13,000 gallons per day	3,500
	$ 4,200

These items would increase the total cost per acre from $11,000 to $15,200.

Treatment may be needed even though a stream or sewer is available.

In many cases some treatment of sewage is needed, even though a stream or sewer is available to carry off the waste water. This treatment may be needed to reduce the pollution of the stream or reduce the load and the cost for existing public sewage disposal systems. The treatment should reduce the suspended solids and the BOD of the sewage.

The trickling filter, so named because of the method by which water is applied, is a method commonly used. This involves the application of waste water to a gravel bed 6 to 8 feet deep. The waste water is applied at intervals by a distributor and allowed to trickle down over the stones and come in contact with bacteria on the surface of the stones. The pollution of the water is reduced by these bacteria. Only part of the water comes in contact with the stones when it trickles down, and for this reason only part

of the organic matter is decomposed during one application. Recirculation of waste water is commonly employed for more satisfactory results.

Costs vary, depending upon volumes of wastes handled and their strength. With recirculation, investment costs can be reduced, since a given amount of gravel can handle a larger volume of water.

The cost of a trickling filter is based on the volume (acre-footage) of stone media required by the formula set forth in a report of the National Research Council of May 1946, and on prevailing engineering cost estimates for the filter components. Estimates are presented in table 16.

Table 16.--Trickling filters: Estimated construction costs and annual operating costs for various types of wastes.

Type of waste	Daily volume of waste 1/	Construction costs: With recirculation 2/	Construction costs: Without recirculation	Annual operating costs: With recirculation 2/	Annual operating costs: Without recirculation
	Gallons	Dollars	Dollars	Dollars	Dollars
Processing waste water only (BOD 515 ppm)	12,500	8,200	17,400	6,520	6,570
	25,000	15,600	36,800	7,900	10,190
	50,000	32,600	72,600	12,720	19,500
	100,000	62,600	143,000	18,300	31,600
Processing waste including blood (BOD 2,050 ppm)	12,500	13,750	28,900	7,570	8,700
	25,000	21,900	52,000	9,090	13,000
	50,000	51,000	114,000	16,300	26,200
	100,000	102,500	232,000	25,750	48,200
Processing waste including manure (BOD 2,200 ppm)	12,500	46,250	106,000	13,620	23,100
	25,000	93,500	214,000	22,400	43,100
	50,000	148,000	260,000	34,200	72,000
	100,000	360,000	730,000	73,600	140,800
Processing waste including blood and manure (BOD 3,300 ppm)	12,500	67,500	158,000	15,800	32,700
	25,000	137,400	318,000	30,600	62,500
	50,000	264,000	644,000	55,800	124,800
	100,000	430,000	1100,000	86,500	210,000

1/ At 1 gallon per pound live weight.
2/ Provides for recirculation of four times the rate at which waste water enters the system.

Usually a poultry processor will choose the method of disposal that is least costly. If he is situated so that all alternatives are available to him, his preference, solely in terms of costs, probably would be as follows:

1. Discharge into open stream, if permitted by public authorities.

2. Use of municipal sewers.

3. Use of spray irrigation.

4. Use of tile fields.

5. Use of recirculating filter before discharge into stream.

6. Use of single-cycle filter before discharge into stream.

Often, however, his choice is limited. Local ordinances or public opinion may prevent the use of open streams without treatment of wastes. Restrictions on space may rule out spray irrigation or tile field methods.

Costs for a given method of disposal or treatment vary with the volume of waste. For a tile field, city sewer, or trickling filter, the cost increases in proportion to the volume. For a spray irrigation system, costs increase less rapidly than waste volumes. Figure 14 shows construction costs for various volumes. Figure 15 shows annual costs for comparable volumes.

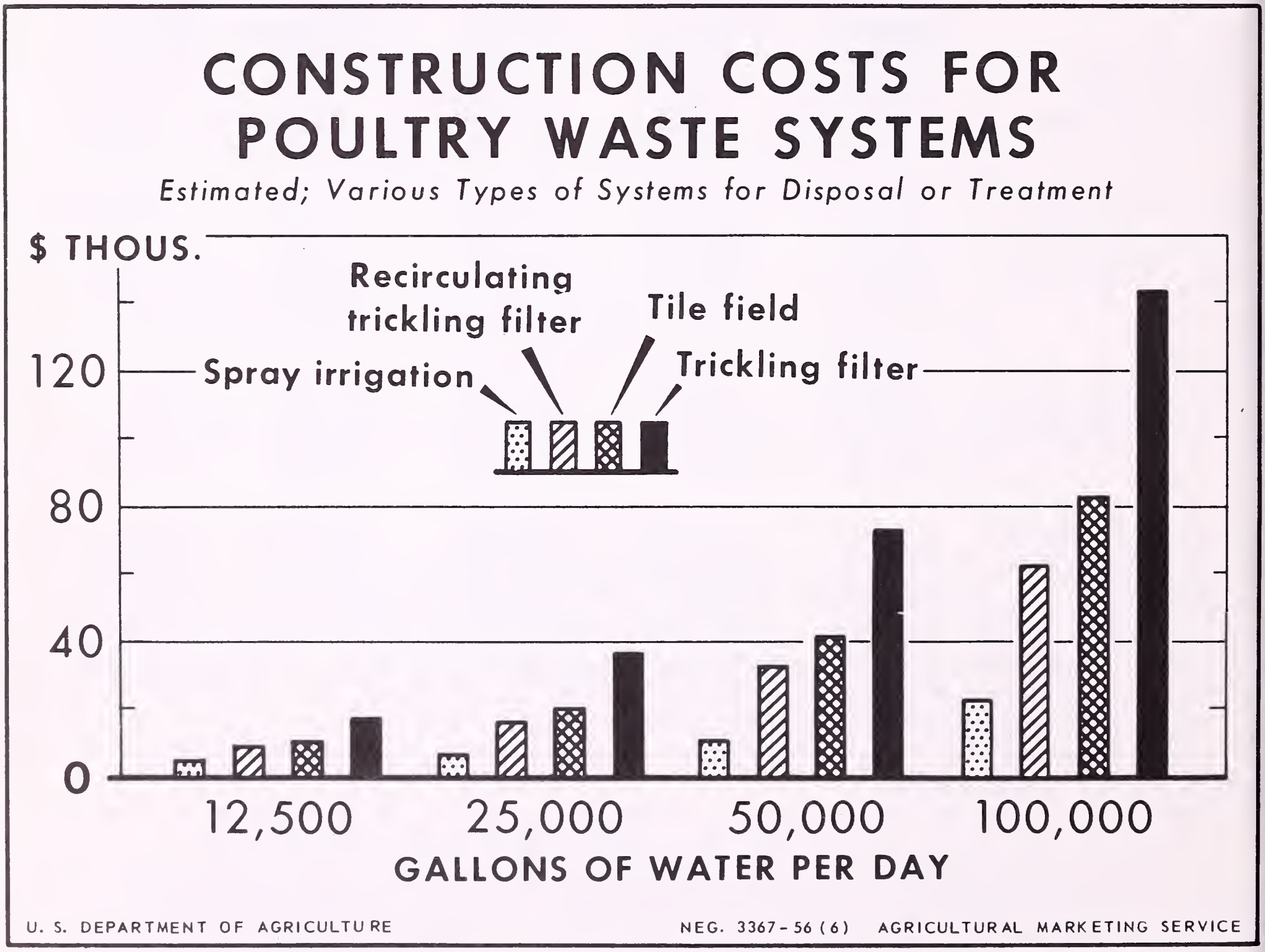


Figure 14.--Construction costs for spray irrigation are less than for other systems of sewage disposal or treatment systems.

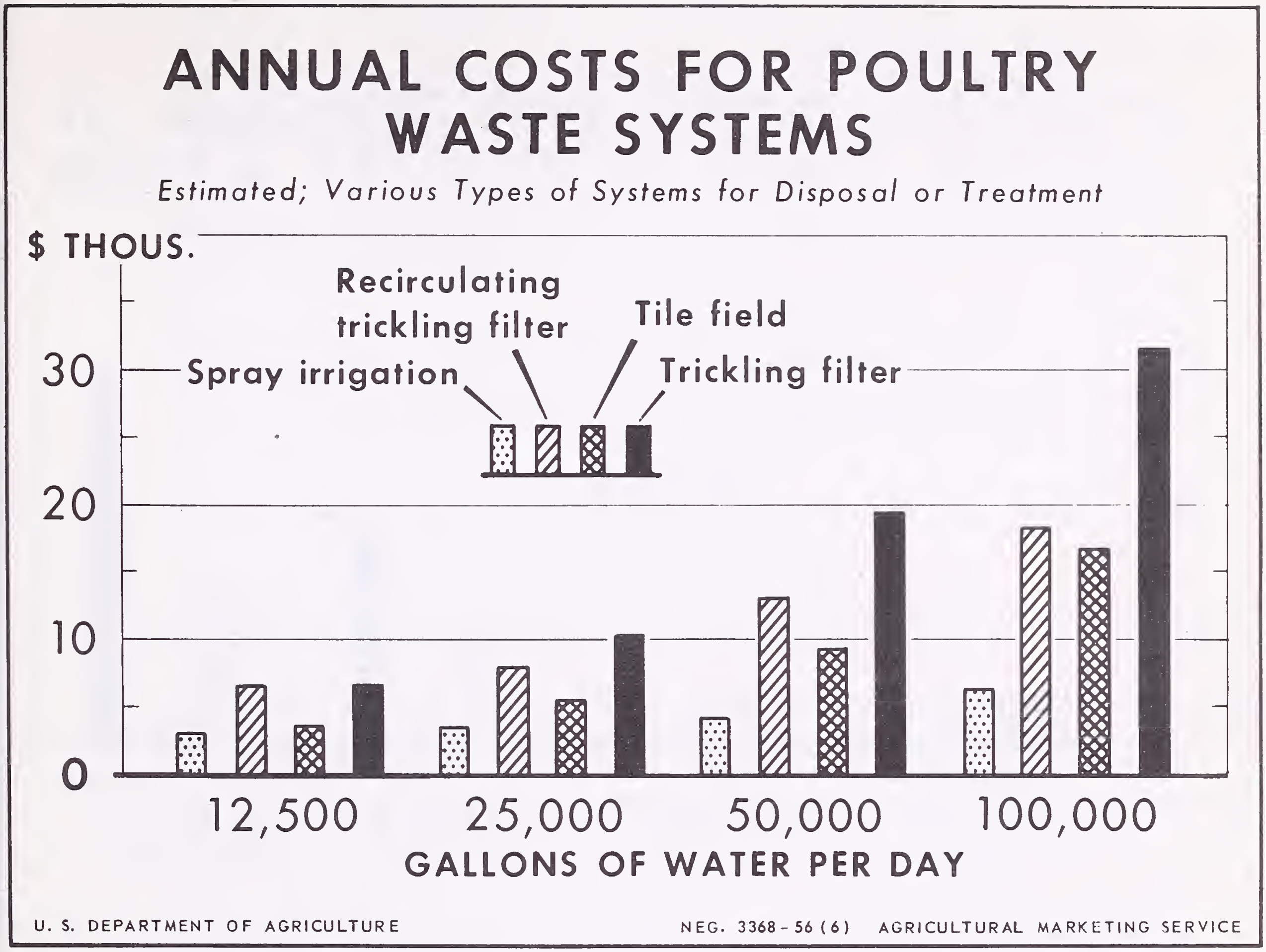


Figure 15.--Annual operating costs are lowest for a spray irrigation system where it is feasible.

The strength of the waste does not materially affect the cost of the spray irrigation system or the tile field. City sewer costs may increase with increases in the strength of the waste. Costs for trickling filters increase as the strength of the waste increases.

Good housekeeping can help hold costs of treatment and probably costs of disposal to a minimum. Withholding manure from the sewers, reduces the volume of waste, as well as its strength. Withholding blood greatly reduces the strength in terms of BOD concentration, but it changes the volume relatively little. Most plants can collect both the blood and manure. Small plants can thereby reduce their annual costs by 60 or 70 percent insofar as municipal treatment or trickling filters are concerned. Large plants can reduce their sewage costs by as much as 85 percent by employing good housekeeping practices. Figure 16 shows costs for wastes of various kinds.

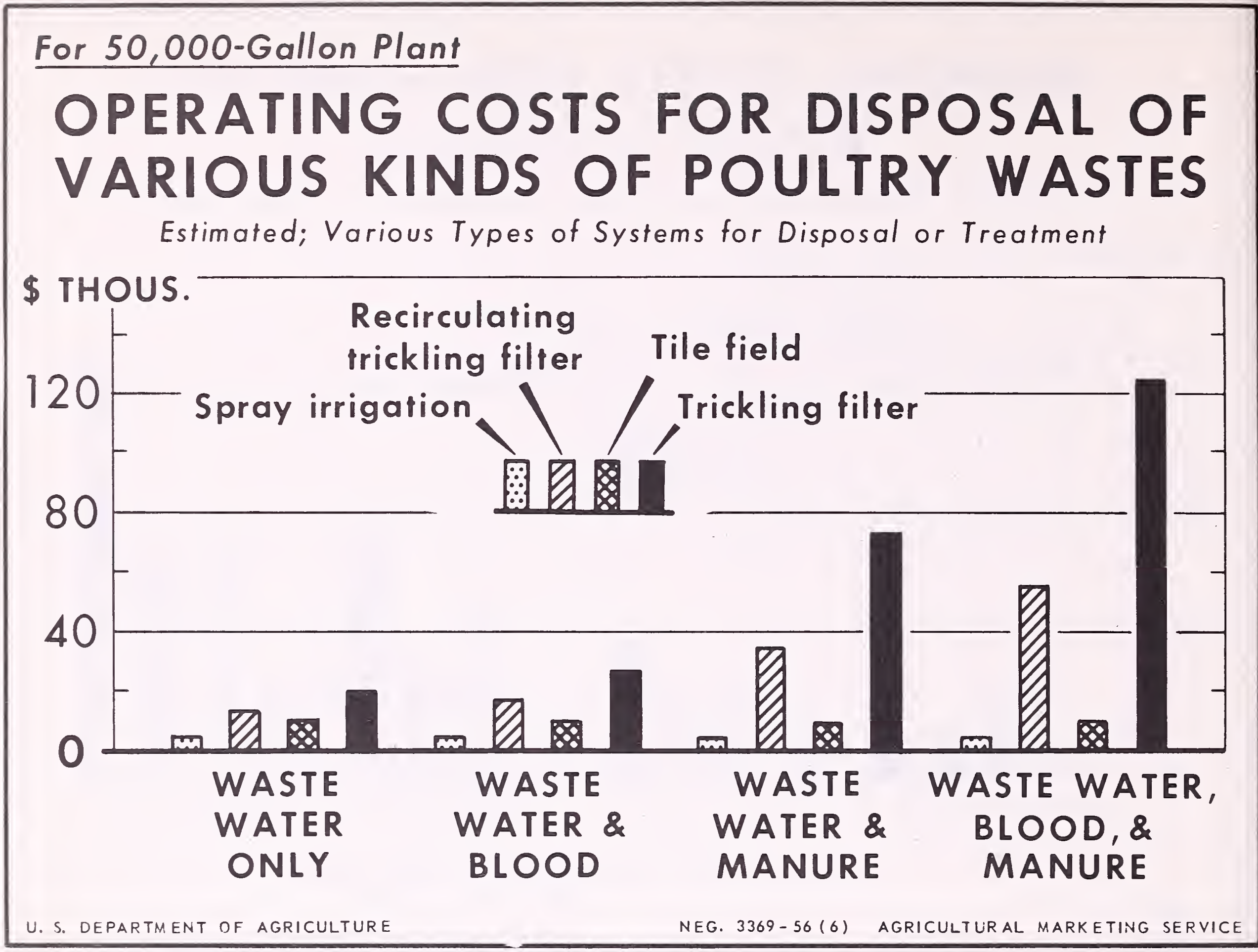


Figure 16.--Operating costs can be kept at a minimum with spray irrigation or with separate disposal of blood and manure.

Recommendations for Waste Water Disposal or Treatment

1. Good housekeeping and water conservation may postpone or eliminate the need for construction of additional disposal or treatment facilities. Where such facilities are needed, good housekeeping and water conservation minimize costs.

2. Consistently good housekeeping is essential to reduce disposal costs regardless of method of disposal or treatment.

   a. Blood should be excluded.

   b. Batteries should be scraped or, if they must be washed, the washings should go through separate sewers to "sludge beds" where settling will take place. The liquid effluent can then be added to the regular waste flow, and the settled manure hauled to nearby farm lands.

3. Conservation of water also is essential to reduce costs. This does not mean a reduction in sanitation but more control over unattended hoses and the re-use of slightly polluted water for cleanup or battery washing. Water to be re-used can be improved in quality and odor by chlorinating it before it is recirculated.

4. The use of a municipal sewer system is generally to be preferred where it is available and where costs are not too far out of line with alternative methods of disposal.

5. Spray irrigation is being used by many food processing industries. Research is needed to determine its applicability to poultry waste water and to establish all of the conditions under which it can be used. This should involve the determination of maximum values of the daily application rate, resting period, and suitable cover crops for various soils and various climates. It appears to offer the lowest cost of any disposal method, and, in certain areas, it may yield a revenue from increased forage crops.

6. Special research is needed to develop an effective low-cost method of removing manure from water used for battery washing.

7. Treatment devices need to be studied with respect to their efficiency in reducing the BOD of waste water from poultry processing. This includes consideration of trickling filters and activated sludge tanks. ("Activated sludge" is the term applied to a process similar to the trickling filter without the stone. Air is pumped into the treatment plant to keep the bacteria in suspension and to meet the BOD. This process produces a higher degree of treatment than the trickling filter process.) Special consideration must be given to the size of treatment plant required for various levels of operation, to variations in daily use, and to adaptability to temporary overloading.

8. Specifications and general plans for low-cost construction should be developed for use by the consulting engineer in charge of designing facilities for a plant.

9. A study of the relation between the volume of poultry slaughtered (pounds live weight) and the pounds of BOD and suspended solids is needed to assist the consulting engineer in evaluating the strength of the waste.

APPENDIX

Recommendations of the Poultry Advisory Committee have included:

May 21, 1948

Recommendation of the Poultry Advisory Committee for consideration in planning the 1950 Research and Marketing Act program.

Byproduct utilization: Inquiring into possibilities for developing new commercially feasible outlets for such materials as feathers, blood, viscera, feet, heads, bone, glands, egg shells, technical albumen, offal, manure, and litter.

May 13, 1949

Problems recommended by the Poultry Advisory Committee for consideration when the 1951 Research and Marketing Act program is planned:

Byproduct utilization: Inquire into possibilities for developing new commercially feasible outlets for such materials as feathers, blood, viscera, feet, heads, bone, glands, egg shells, technical albumen, offal, manure, and litter.

April 25, 1950

Poultry Research and Marketing Advisory Committee Report:

Byproduct utilization: Inquire into possibilities for developing new commercially feasible outlets for such materials as feathers, blood, viscera, feet, heads, bone, glands, egg shells, technical albumen, offal, manure, and litter.

March 10, 1953

Recommendations of the Poultry Advisory Committee:

Poultry and egg waste utilization: Seek high-value byproducts from feathers, viscera, and inedible eggs.

April 5, 1955

Recommendations of the Poultry Research and Marketing Advisory Committee:

Costs and efficiency in disposing of poultry dressing plant and hatchery wastes. Expand research on the costs and efficiency of disposing of wastes from poultry dressing plants and hatcheries, including detailed economic analyses of alternate methods of assembling, processing, and distributing waste materials and the byproducts made from these wastes.

Table 1.--Inedible broiler and turkey byproducts recovered during a normal day's operation of a commercial slaughter plant, Virginia, June 1955.

Item	Broilers		Turkeys	
Number slaughtered	22,288		4,476	
Average live weight (lbs.)	3.18		8.38	
Gross live weight (lbs.)	70,876		37,509	
	Total weight	Percentage of live wt.	Total weight	Percentage of live wt.
	Pounds	Percent	Pounds	Percent
Blood	2,406	3.4	1,037	2.8
Feathers				
From pickers	11,267	15.9	7,200	19.2
Drained (overnight) ..	7,324	10.3	4,594	12.2
Baled	6,197	8.7	3,931	10.5
Dry weight based on yield of 33 percent for baled feathers...	2,045	3.0	1,297	3.5
Heads	2,413	3.4	1,098	2.9
Feet	3,771	5.3	1,216	3.2
Viscera (including water)	9,007	12.7	3,262	8.7
Total offal	15,191	21.4	5,576	14.8

\- - -

Typical Processing Shrinkage

Gross returns from poultry byproduct rendering depend upon the volume of byproducts which become available per 1,000 pounds of poultry slaughtered. However, interviews with plant managers failed to establish reliable estimates of recoverable inedible products. Because of the relatively low value of the inedible materials poultry slaughterers seldom weighed the material and rarely made adjustments for water added.

Some information was obtained, however, regarding the shrinkage incurred during processing. This is a percentage which most slaughterers have on record. It represents the difference, in percentage terms, between the live weight purchased and the dressed and eviscerated weight sold. It is affected by dead or condemned birds, and processing procedures. Recently developed techniques of cooling and processing have greatly reduced shrinkage. Data collected during the 1955 survey of representative commercial poultry slaughterers and through other studies suggest the following:

Table 2.--Typical shrinkage percentages in commercial poultry processing, by classes of poultry.

Class of poultry	Percentage of live weight lost in processing	Class of poultry	Percentage of live weight lost in processing
Chickens		Turkeys	
Broilers and fryers	28.0	Fryer roasters.	24.0
Roasters	27.6	Heavy hens	20.4
Fowl	27.0	Heavy toms	19.1
All chickens .	27.8	All turkeys .	20.3
Ducks	27.0	Geese	22.5

The estimates above are smaller than those released earlier by the Department and are subject to revision when a thorough study can be made.

The percentage of recoverable inedible products will differ from the above shrinkage figures because of (1) losses of byproducts during processing, most frequently encountered with blood, and (2) addition of water during processing, as is the case with feathers. The percentage of recoverable byproducts will vary with the condition of the poultry (36), the weight and sex (38), and the breeding (11).

Work now under way should lead to more precise estimates of recoverable inedible products in terms of ratios of dried byproduct yields to live weight of poultry slaughtered.

\- - -

Institutions making preliminary feathermeal and other poultry byproduct meal feeding tests in 1956 include:

Department of Poultry Husbandry, Clemson Agricultural College, Clemson, South Carolina.
Department of Poultry Husbandry, Texas Agricultural Experiment Station, College Station, Texas.
American Meat Institute Foundation, University of Chicago, Chicago 37, Illinois.
Department of Poultry Husbandry, University of Maryland, College Park, Maryland.
Department of Biochemistry and Nutrition, Virginia Agricultural Experiment Station, Blacksburg, Virginia.
Maine Agricultural Experiment Station, Orono, Maine.
Department of Poultry Husbandry, Rutgers University, New Brunswick, New Jersey.
Department of Poultry Husbandry, Oregon State College, Corvallis, Oregon.
Animal and Poultry Husbandry Research Branch, U. S. Department of Agriculture, Beltsville, Maryland.
University of Tennessee, Agricultural Experiment Station, Knoxville, Tennessee.

- - -

BIBLIOGRAPHY

Feathers

(1) Anonymous.
October 1945, Feather Fabric. Poultry Comment, Vol. 2, No. 4:3, illus.

(2) -------.
January 12, 1952. USDA Research Uncovers New Market Possibilities for Feathermeal. National Provisioner. 126(a): 11, 25-27.

(3) -------.
June 1942, Feathers an Important Industry Byproduct. U. S. Egg and Poultry Magazine. Vol. 48, No. 6: 339-340, 378-380.

(4) Binkley, C. H., and Vasak, O. R.
June 1950, Production of a Friable Meal from Feathers (cost estimates). U. S. Dept. Agr., ARA, Inf. Cir. AIC-274, 5 pp.

(5) -------.
February 1951, A Friable Meal Produced From Feathers. Amer. Egg and Poultry Rev. Vol. 12, No. 2: 68,70,72.

(6) Draper, C. I.
May 1944, The Nutritive Value of Corn Oil Meal and Feather Protein. Iowa Agr. Exp. Sta., Res. Bul. 326, 184 pp.

(7) Drews, Harry E.
October 1943, Wartime Demands Step Up Use of Feathers. U. S. Egg and Poultry Mag. Vol. 49, No. 10: 440-442.

(8) Hardy, John I., and Hardy, Thora M. Plitt.
February 1949, Feathers from Domestic and Wild Fowl. U. S. Dept. Agr. Cir., No. 803, 27 pp., illus.

(9) Harms, R. H., and Goff, O. E.
June 1956, Feathers Make Good Poultry Feed. Tenn. Farm and Home Sci., Univ. of Tenn. Agr. Expt. Sta., Prog. Report No. 18, p. 4.

(10) McNally, E. H.
December 1955, Feathers a Valuable Byproduct. Poultry Proc. and Market. Vol. 61, No. 12: 19-22, illus.

(11) Jaap, R. George, and Turner, Kirk
February 1943, Number of Feathers of Different Breeds and Varieties. U. S. Egg and Poultry Mag. Vol. 49, No. 2: 74-75, 90-94.

(12) Kraybill, H. R.
April 2, 1954, Feathermeal. Amer. Meat Inst. Foundation, Res. Prob. No. 57-14, Prob. Outline Nos. 1,2,3, and Summary Report, 33 pp. Chicago. (Processed.)

(13) Lillie, Robert J., Sizemore, J. R., and Denton, C. A.
1956, Feather Meal in Chick Nutrition. Poultry Sci.: 35: 316-318.

(14) Lookabaugh, George S.
February 1945, Chicken Feather Wool. Amer. Poultry Jour. Vol. 76, No. 2: 18.

(15) Lundgren, H. P.
1951, Feathers as a Source of Fibers. U. S. Dept. Agr. Yearbook 1950-51: 481-83.

(16) -------, Lineweaver, H., and McNally, E. H.
1951, Utilization of Poultry Wastes. U. S. Dept. Agr. Yearbook 1950-51: 869-876.

(17) Roberts, N. E.
December 1951, Filling Materials - Problem in Military Sleeping Bags. Bedding: Vol. LXI, No. 5: 52-55.

(18) -------, and Weiner, L. I.
December 1952, Recent Developments in Army Sleeping Gear. Bedding: Vol. LXIII, No. 5: 48-54.

(19) U. S. patents issued in reference to feather processing:

Tor Hoeven	June 23, 1868	U.S. Patent	79,160
Johns	Feb. 11, 1871	"	111,851
Richardson	Oct. 1, 1878	"	208,540
Harris	June 6, 1882	"	259,140
Smith	May 10, 1892	"	474,419
Schmelzer	Nov. 17, 1925	"	1,561,667
Jurale	Aug. 22, 1939	"	2,170,562
Mayer	1955	"	2,702,245

(20) Virginia Ext. Serv.
June 1953, Feathers in Feed Tried at Station. Va. Ext. Serv. News, Blacksburg, Va.

(21) Wilder, O. H. M., Otsby, P. C., and Gregory, B. R.
1955, The Use of Chicken Feather Meals in Feeds. Amer. Meat Inst. Foundation, Jour. Paper No. 99. Chicago. (Processed.)

Offal

(22) Bassett, C. F., and Wilke, Ford
November 1948, The Comparative Value of Poultry Waste and Horse Meat for Feeding Mink. Amer. Fur Breeder v. XXI, No. 5:40-44.

(23) Danzansky, J. B.
1945, Poultry Byproducts: Useful Products May be Made From What is Now Considered Offal. Amer. Egg and Poultry Rev. v. 6, No. 9:455.

(24) Hartsough, G. R.
August 1946, Our Present Feeding Problems. Natl. Fur News 7.

(25) Howell, Roland E.
July 1951, The Effect of Poultry Byproducts on Mink Reproduction. Amer. Natl. Fur and Market Jour. 13.

(26) Kellogg, Charles E., et al.
April 1954, Mink Raising. U. S. Dept. Agr. Cir. No. 801, rev., 42 pp., illus.

(27) Landon, Harry
August 1952, How to Process Poultry Byproducts. The Black Fox Mag. and Modern Mink Breeder 9.

(28) Morris, Mark L.
1946, Poultry Byproducts for Feeding Pet Animals. No. Amer. Vet., v. 27, No. 11: 703-704.

(29) Richardson, T. C.
November 1954, How to Use Chicken Waste. The Black Fox Mag. and Modern Mink Breeder 27.

(30) Schweigert, B. S., et al
October 1952, Use of Inedible Fats in Dry Dog Foods and Poultry Rations. Amer. Meat Inst. Foundation Bul. 15, 11 pp., Chicago.

(31) Shrader, H. C.
December 1945, Poultry Byproducts. Amer. Poultry Jour. 5:44-46.

(32) Stewart, George Franklin, and Mussehl, Frank E.
September 1941, The Recovery of Byproducts from Poultry Evisceration Wastes. Poultry Sci., v. XX, No. 5:450-453.

(33) U. S. Bur. Animal Ind.
February 1950, Suggestions in Feeding Poultry Waste to Mink. U. S. Dept. Agr. Bur. Animal Ind., 2 pp. (Processed).

Miscellaneous

(34) Drews, Harry E.
August 1953, Poultry Byproducts Must be Marketed. Poultry Proc. and Market. v. 59, No. 8:12-13, 21-22.

(35) Goff, O. E.
December 1951, Why Throw Potential Profits Down the Drain? U. S. Egg and Poultry Mag. v. 57, No. 12:9-10, 24-26.

(36) Jull, M. A., and Maw, W. A.
June 1923, Determinations of the Dressed, Drawn, and Edible Percentages of Various Kinds of Domestic Birds. Sci. Agr. v. 3, No. 10:329-338.

(37) Kahle, Humbert S.
March 1955, Poultry Plant Waste Disposal. Market Activ., U. S. Dept. Agr., AMS.

(38) Mitchell, H. H.; and Card, L. E., and Hamilton, T. S.
June 1926, The Growth of White Plymouth Rock Chickens. Ill. Univ. Agr. Expt. Sta. Bul. 278, 132 pp.

Manure

(39) Anderson, M. S., and Gaddy, V. L.
1947, Poultry Manure as a Fertilizer. U. S. Dept. Agr., Agr. Res. Admin., Bur. Plant Indus., Soils and Agr. Engin., 6 pp. (Processed).

(40) Donaldson, Ralph W.
1943, Poultry Manure - Its Use and Preservation. Mass. Agr. Ext. Serv. Ext. Leaflet 57.

(41) Gustafson, A. F., and Weaver, L. E.
1944, Poultry Manures - Their Production and Use. New York Agr. Expt. Sta. Bul. 641.

(42) Meyer, Sylvan
September 1953, New Plant Food from Poultry Manure. Poultry Proc. and Market. v. 59, No. 9:15, 22.

(43) Moore, O. K.; Mehrhof, N. R., and Allison, R. V.
1945, Conservation and Use of Poultry Manure. Turkey World v. 20, No. 9: 30-32, 58, 60.

(44) Popanos, Stanley, and Brown, B. A.
December 1950, Poultry Manure - Its Nature, Care, and Use. Storrs Agr. Expt. Sta. Bul. 272.

(45) White, J. W.; Holben, F. J., and Richer, A. C.
November 1944, Production, Composition, and Value of Poultry Manure. Pa. State Col. Agr. Expt. Sta. Bul. 469, 42 pp., illus.

(46) Yushok, Wasley, and Bear, Firman E.
October 1948, Poultry Manure - Its Preservation, Deodorization, and Disinfection. N. J. Agr. Expt. Sta. Bul. 707, 11 pp.

Sewage

(47) Bell, James W.
September 1955, Spray Irrigation for Poultry and Canning Wastes. Pub. Works v. 86, No. 9:111-112.

(48) Heukelekian, H.; Osford, H. E., and Cherry, J. L.
1950, the Characteristics of Wastes from Chicken Packing Plants. Sewage and Indus. Wastes v. 22, No. 4:521-530.

(49) Heuvelen, W. Von
October 1952, Sewage Disposal by the Lagoon Method. Offc. Bul. N. Dak. Water and Sewage Works Conf. 22:4.

(50) Porges, Ralph
1950, Wastes from Poultry Dressing Establishments. Sewage and Indus. Wastes v. 22, No. 4:531-535.

(51) Ryan, William A.
January 1950, Industrial Waste Lagoons. Sewage and Indus. Wastes v. 22, No. 1:71-75.

(52) Schroepfer, George, Jr.; Fullen, W. J.; Johnson, A. S., and others
April 1955, The Anaerobic Contact Process as Applied to Packinghouse Wastes. Sewage and Indus. Wastes v. 27, No. 4:460-486.

(53) Searles, G.
January 1950, (discussions of articles by Heukelekian and Porges). Sewage and Indus. Wastes v. 22, No. 1:75-76.

(54) Weiss, Marvin D.
1951, Industrial Water Pollution. Survey of Leg. and Regulat., 142 pp. N.Y.

(55) Wolf, A., and Woodring, W. T.
1953, Wastes from Small Poultry Dressing Establishments. Sewage and Indus. Wastes v. 25:1429-31.

☆U. S. GOVERNMENT PRINTING OFFICE : 1956 O - 409018